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BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE ESTUARY AT THE LCP CHEMICAL SITE IN BRUNSWICK, GEORGIA

CDR Environmental Specialists

Site Investigation/Analysis And Risk Characterization

Volume I

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SUMMARY

This report presents the results of the "Site Investigation/Analysis" (Procedures) Phase and "Risk Characterization" Phase (Steps 6 and 7) of a baseline ecological risk assessment (BERA) conducted for the LCP Chemical Site in Brunswick, Georgia. Initial components of the risk assessment process – in particular, "Problem Formulation" (Step 3) and "Study Design and Data Quality Objectives" (Step 4) – are referenced, but not presented in their entirety, in this report.

The major chemicals of potential concern (COPC) addressed in the BERA are mercury (including methylmercury and inorganic mercury), Aroclor 1268, lead, and polynuclear aromatic hydrocarbons (PAHs). However, other chemicals are also evaluated during the risk assessment.

Site Investigation/Analysis (Procedures)

The site investigation of the BERA was conducted during the period of October 10 – 19, 2000. The site was arbitrarily divided into three major sections (southern, northern, and western parts), which extended from upper Purvis Creek to the Turtle River (in a northerly-to-southerly direction) and from the shoreline to the western boundary of Purvis Creek (in an easterly-to-westerly direction). Sampling stations were then authoritatively established in creek and marsh environments in each of the sections. A total of 52 sampling stations (46 "regular" stations, 5 stations in a previously remediated "marsh grid," and 1 shoreline station where seepage of fluids was observed) was established throughout the site. Two reference locations – one at Troup Creek and the other in the Crescent River – were also established.

Sampling stations were selectively evaluated for surface water chemistry, chronic toxicity of surface water, surface sediment (from 0 to 15 cm in depth) chemistry, chronic toxicity of surface sediment, surface sediment biota (community characteristics of benthic macroinvertebrates), and body burdens (concentrations) of major COPC in "whole bodies" of a variety of biota (i. e., cordgrass, fiddler crabs, insects, mummichogs, blue crabs, and several sciaenid fishes including silver perch).

The above-referenced primary site investigation and analysis was supplemented by results of several studies previously conducted at the site. These secondary studies consisted of evaluations of COPC in eggs of diamondback terrapins (*Malaclemys terrapin*) captured at the site, histopathology examinations of indigenous diamondback terrapins and clapper rails (*Rallus longirostris*), evaluations of COPC in livers of indigenous clapper rails, and a survey of wading birds in the area.

Risk Characterization

The risk characterization phase of the BERA consists of three basic parts: 1) risk estimation; 2) risk description; and 3) uncertainty analysis.

Risk Estimation

Risk estimation focuses on the following eight assessment endpoints and associated measurement endpoints (lines of evidence) listed below according to their generally increasing ecological significance. In this summary, important results of the BERA are presented according to applicable assessment endpoints.

Assessment Endpoint 1 – Viability of the benthic estuarine community specifically in terms of structure and function, as evaluated by three measurement endpoints: 1) comparisons of concentrations of COPC in surface sediment to general literature-based effects levels; 2) results of chronic toxicity tests conducted with sensitive life stages of benthic aquatic life; and 3) evaluation of the benthic macroinvertebrate community structure at the site.

Concentrations of total mercury (0.048 - 110 mg/kg, dry wt) and Aroclor 1268 (0.015 - 23 mg/kg) in creek surface sediment at the LCP Site were almost always greater than applicable ecological effects values (EEVs; 0.13 mg/kg for total mercury and 0.0216 mg/kg for total PCBs) promulgated by Region 4 of the U. S. Environmental Protection Agency (U. S. EPA). Lead (3.7 - 1,100 mg/kg) was sometimes elevated above Region 4's EEV (30.2 mg/kg), and total PAHs (0 - 17 mg/kg) were seldom elevated over their EEV (1.684 mg/kg). No consistent patterns of mercury or Aroclor 1268 concentrations were observed in surface sediment collected at various locations along three transects extending across the creek system into the marsh.

For marsh surface sediment at the site, the same above-described general relationships were observed between concentrations of total mercury (0.12 - 63 mg/kg, dry wt) and lead (2.4 - 120 mg/kg) vs. applicable EEVs. However, concentrations of Aroclor 1268 (0.043 - 4.9 mg/kg) always exceeded the EEV for total PCBs; and levels of total PAHs (0 - 1.4 mg/kg) were never elevated above their EEV.

Chronic toxicity tests with amphipods (*Leptocheirus plumulosus*) and grass shrimp (*Palaemonetes pugio*) exposed in the laboratory to creek surface sediment generated similar results. Survival of amphipods exposed to sediment from the site was significantly lower than survival of reference (Troup Creek) organisms at only two sampling stations (Stations K7 and H7) out of five sampling stations evaluated in the marsh grid. Survival of grass shrimp at these two sampling stations and at seven other stations in the marsh grid and Purvis Creek system usually was not significantly lower than survival of some reference organisms. However, these two sampling stations, as well as three out of four stations in the Purvis Creek system (Stations 5, 7, and 33), were characterized by impaired reproductive processes of shrimp.

The highest linear coefficients of determination (r^2) between chemistry of sediment and amphipod toxicity occurred for lead ($r^2 = 0.42 - 0.54$) and total PAHs ($r^2 = 0.55 – 0.56$). For grass shrimp, the highest r^2 values were also noted for lead in sediment vs. percent of surviving females producing embryos ($r^2 = 0.69$) and percent of embryos hatching ($r^2 = 0.54$).

The benthic macroinvertebrate community at the four stations that were evaluated in the Purvis Creek system (Stations 5, 7, 16, and 33) appeared unremarkable in comparison to the communities at the reference locations with regard to the Shannon-Weaver diversity index (d) and the Lloyd-Ghelardi equitability index (e).

The first two of the above-identified lines of evidence indicate that there is a potential risk to the structure and function of the benthic estuarine community at selected locations at the LCP Site. The above-referenced r^2 values indicate that this risk is more associated with sedimentary lead and PAHs, rather than mercury or Aroclor 1268. The risk may be greatest to environmentally naïve benthos (as evidenced by results of the chronic toxicity tests) as contrasted to environmentally acclimated benthos (as judged by the study of the benthic macroinvertebrate community at the site).

<u>Assessment Endpoint 2</u> – Viability of omnivorous reptiles utilizing the marsh and Purvis Creek, as evaluated by three measurement endpoints: 1) comparisons of concentrations of COPC in eggs of diamondback terrapins captured at the site to general literature-based effects levels; 2) hazard quotients (HQs) derived from a food-web exposure model for the terrapin; and 3) results of histopathology examinations (e. g., liver and neural abnormalities) of terrapins captured at the site.

In a study conducted in 1995, the eggs from three female diamondback terrapins obtained from the site were characterized by mean concentrations of the following COPC (all egg concentrations expressed as dry wt) – Female 1 (BD1): 0.87 mg/kg mercury and 29.7 mg/kg Aroclor 1268; Female 2 (DD4): 2.2 mg/kg mercury and 28.6 mg/kg Aroclor 1268; and Female 3 (DD5): 4.6 mg/kg mercury and 480 mg/kg Aroclor 1268. Although eggs from Female 2 did not hatch, eggs from the other females – which contained higher concentrations of mercury (Female 3) and Aroclor 1268 (Females 1 and 3) – did hatch. Consequently, elevated concentrations of mercury and Aroclor 1268 in terrapin eggs (even levels that existed in 1995) cannot be implicated as causing failed reproduction in terrapins.

In the same above-referenced diamondback terrapin study, histopathology examination did not indicate any degeneration or abnormality known to be associated with the COPC.

Maximum HQs derived for diamondback terrapins feeding on fiddler crabs (90% of diet) and mummichogs (10%) at the site are 0.0052 for methylmercury, 0.056 for Aroclor 1268, and 0.46 for lead when toxicity reference values (TRVs) employed in the evaluation are no-observed-adverse-effect-level (NOAEL) TRVs. (PAHs were not assessed in terrapins or any other predator because PAHs seldom occurred in evaluated prey of the predators. Similarly, inorganic mercury was ultimately dismissed as a COPC in all predators because of extremely low mean NOAEL HQs [2 to 5 orders-of-magnitude less than 1] for this form of mercury.)

The above-discussed lines of evidence pertaining to the diamondback terrapin egg study and histopathology examination suggest that there is no potential risk to omnivorous reptiles utilizing the marsh and Purvis Creek system at the LCP Site. The line of evidence pertaining to HQ development provides an additional basis for this conclusion.

Assessment Endpoint 3 – Viability of omnivorous avian species utilizing the marsh and Purvis Creek, as evaluated by four measurement endpoints: 1) comparisons of concentrations of COPC in livers of clapper rails captured at the site to general literature-based effects levels; 2) HQs derived from a food-web exposure model for the red-winged blackbird (*Agelaius phoeniceus*); 3) HQs derived from a food-web exposure model for the clapper rail; and 4) results of histopathology examinations (e. g., liver and neural abnormalities) of clapper rails captured at the site.

In a study conducted in 1995, livers of seven clapper rails collected from the southern part of the site contained a mean mercury concentration of 3.84 mg/kg (wet wt) and a mean Aroclor 1268 concentration of 25.2 mg/kg (dry wt). No literature-based effect levels are available for Aroclor 1268 in livers of birds. However, mercury concentrations in bird livers have only been associated with avian mortality at levels of (all reported in terms of wet weight) 126.5 mg/kg (red-winged blackbirds), 54.5 mg/kg (grackles), and 4.6 to 91 mg/kg (white-tailed eagles).

In the same above-cited clapper rail study, histopathology examination did not indicate specific toxicity or specific uniform degeneration of tissues of clapper rails. In particular, myelin sheath and axonal degeneration, characteristic of mercury toxicity, were not observed except in one case, which may have been an artifact. Also, liver necrosis and fatty change, typical of PCB toxicity, were not noted.

Maximum HQs derived for red-winged blackbirds feeding on insects (90% of diet) and fiddler crabs (10%) at the site are 0.31 for methylmercury, 0.058 for Aroclor 1268, and 1.4 for lead when TRVs employed in the evaluation are NOAEL TRVs. The maximum HQ for blackbirds exposed to lead when the lowest-observed-adverse-effect-level (LOAEL) TRV is utilized in the evaluation is 0.14.

Maximum HQs obtained for clapper rails feeding on fiddler crabs (85% of diet), insects (10%), and mummichogs (5%) at the site are 1.3 for methylmercury, 0.26 for Aroclor 1268, and 12 for lead when TRVs employed in the evaluation are NOAEL TRVs. Maximum HQs for clapper rails exposed to methylmercury and lead when LOAEL TRVs are employed in the evaluation are, respectively, 0.65 and 1.2. It is important to note that clapper rails at the Troup Creek reference location are characterized by a relatively high maximum NOAEL HQ for lead of 1.5.

The four above-discussed lines of evidence, considered collectively, indicate that the potential risk to omnivorous avian species utilizing the marsh and Purvis Creek is minimal except in the case of lead. There are no literature-based effects levels available for Aroclor 1268 in livers of birds, and the seemingly safe levels of mercury in bird livers pertain to just avian mortality. However, the histopathology examination of the same birds employed in the liver study documented the absence of numerous sublethal effects diagnostic of mercury and PCB poisoning in birds.

Maximum NOAEL HQs for red-winged blackbirds and clapper rails exposed to COPC approximate or are less than unity (1) except in the case of clapper rails exposed to lead. This unusual case (maximum NOAEL HQ = 12) occurred at a sampling station (Station "AB") where seepage containing high concentrations of total lead (mean concentration of 1,400 ug/L) was being discharged from the land. The main food item for clapper rails – fiddler crabs – at this station were characterized by body burdens of lead that averaged 22.14 mg/kg (dry wt).

Assessment Endpoint 4 – Viability of piscivorous avian species utilizing the marsh and Purvis Creek, as evaluated by four measurement endpoints: 1) comparisons of concentrations of COPC in livers of clapper rails captured at the site to general literature-based effects levels; 2) HQs derived from a food-web exposure model for the green heron *(Butorides striatus)*; 3) results of histopathology examinations (e. g., liver and neural abnormalities) of clapper rails captured at the site; and 4) results of a survey of abundance of wading birds in the area.

Results of the clapper rail study – the liver evaluation and histopathology examination, which were conducted in 1995 – are described above for Assessment Endpoint 3.

Maximum HQs obtained for green herons feeding on mummichogs (90% of diet), blue crabs (5%), and fiddler crabs (5%) at the site are 2.8 for methylmercury, 0.28 for Aroclor 1268, and 27 for lead when TRVs employed in the evaluation are NOAEL TRVs. Maximum HQs for green herons exposed to methylmercury and lead when LOAEL TRVs are employed in the evaluation are, respectively, 1.4 and 2.7. It is noteworthy that green herons at the Troup Creek reference location are characterized by a relatively high maximum NOAEL HQ for lead of 2.4.

The survey of abundance of wading birds, which was conducted in 1996, indicated that wading birds were present at significantly higher numbers at the LCP Site than at a reference site (Hawkins Creek). However, most wading birds were observed at the extreme northern boundary of the LCP Site (including tributaries of the Turtle River), far distant from the areas of greatest contamination by COPC.

The four above-discussed lines of evidence indicate that the potential risk to piscivorous avian species utilizing the marsh and Purvis Creek is minimal except in the case of lead. As discussed for omnivorous birds, literature-based effects levels are not available for Aroclor 1268 in livers of birds, and the seemingly safe levels of mercury in bird livers pertain to just avian mortality. Nevertheless, the histopathology examination of the same birds employed in the liver study documented the absence of numerous sublethal effects diagnostic of mercury and PCB poisoning in birds.

The maximum NOAEL HQ for green herons exposed to Aroclor 1268 is less than unity (1). The maximum NOAEL HQ for methylmercury – 2.8 – is partially discounted by the above-reviewed histopathology results and, also, results of the wading bird survey, which suggest that only limited members of populations of piscivorous birds are likely to be exposed to COPC. In the case of lead, to which results of the wading bird survey also apply, the maximum NOAEL HQ (27) occurred at a sampling station (Station 33, near the old oil-processing site) where concentration of total lead in surface water was a relatively high 7.0 ug/L The main food item for green herons – mummichogs – at this station was characterized by body burdens of lead that averaged 26.00 mg/kg (dry wt).

Assessment Endpoint 5 – Viability of herbivorous mammalian species utilizing the marsh and Purvis Creek, as estimated by HQs derived from a food-web exposure model for the marsh rabbit *(Sylvilagus palustris)*.
Maximum HQs obtained for marsh rabbits feeding on cordgrass (100% of diet) at the site are 0.054 for methylmercury, 1.2 for Aroclor 1268, and 28 for lead when TRVs employed in the evaluation are NOAEL TRVs. Maximum HQs for rabbits exposed to Aroclor 1268 and lead when LOAEL TRVs are employed in the evaluation are, respectively, 0.12 and 2.8. Rabbits at the Troup Creek and Crescent River reference locations are characterized by relatively high maximum NOAEL HQs for lead of, respectively, 7.8 and 13.

This single line of evidence (HQ development) suggests that the potential risk to herbivorous mammalian species utilizing the marsh and Purvis Creek is minimal except in the case of lead. Maximum NOAEL HQs for marsh rabbits exposed to COPC approximate or are less than unity (1) except in the case of rabbits exposed to lead. For lead, the maximum NOAEL HQ (28) occurred at a sampling station (Station 40, near the old oil-processing site) where concentration of lead in cordgrass (the food item for rabbits) was characterized by an unexpectedly high mean value of 7.60 mg/kg (dry wt). At the other eight sampling stations for which HQs were developed for rabbits exposed to lead, maximum NOAEL HQs approximate the values generated by the two reference locations.

Assessment Endpoint 6 – Viability of omnivorous mammalian species utilizing the marsh and Purvis Creek, as estimated by HQs derived from a food-web exposure model for the raccoon *(Procyon lotor)*.

Maximum HQs obtained for raccoons feeding on fiddler crabs (45% of diet), blue crabs (45%), and mummichogs (10%) at the site are 4.7 for methylmercury, 5.0 for Aroclor 1268, and 47 for lead when TRVs employed in the evaluation are NOAEL TRVs and an area-use-factor (AUF) of 1 is assumed. Comparable site HQs for an AUF of 0.3 are 1.4 for methylmercury, 1.5 for Aroclor 1268, and 14 for lead. Raccoons at the Troup Creek and Crescent River reference locations are characterized by relatively high maximum NOAEL HQs for lead of, respectively, 6.9 and 4.1.

Maximum site-related HQs for raccoons are 2.8 for methylmercury, 0.50 for Aroclor 1268, and 4.7 for lead when LOAEL TRVs are employed in the evaluation and an AUF of 1 is assumed. Comparable site HQs for an AUF of 0.3 are 0.81 for methylmercury, 0.15 for Aroclor 1268, and 1.4 for lead.

This single line of evidence (HQ development) suggests that there is a potential risk to omnivorous mammalian species in some areas of the marsh and Purvis Creek, particularly with the assumptions of NOAEL TRVs and an AUF of 1. The highest HQs for all COPC (i. e., methylmercury, Aroclor 1268, and lead) occurred at a sampling station (Station "AB") where seepage containing relatively high mean concentrations of methylmercury (23 ng/L), Aroclor 1268 (0.52 ug/L), and total lead (1,400 ug/L) was being discharged from the land. One of the main food items for raccoons – fiddler crabs – at this station was characterized by body burdens of methylmercury, Aroclor 1268, and lead that averaged, respectively, 0.611, 3.03, and 22.14 mg/kg (all in dry wt).

<u>Assessment Endpoint 7</u> – Viability of piscivorous mammalian species utilizing the marsh and Purvis Creek, as estimated by HQs derived from a food-web exposure model for the river otter *(Lutra canadensis)*.

Maximum HQs obtained for river otters feeding on silver perch (50% of diet), mummichogs 30%), blue crabs (10%), and fiddler crabs (10%) at the site are 6.2 for methylmercury, 6.3 for Aroclor 1268, and 34 for lead when TRVs employed in the evaluation are NOAEL TRVs and an area-use-factor (AUF) of 1 is assumed. Comparable site HQs for an AUF of 0.66 are 4.1 for methylmercury, 4.3 for Aroclor 1268, and 23 for lead. River otters at the Troup Creek reference location are characterized by a relatively high maximum NOAEL HQ for lead of 5.3.

Maximum site-related HQs for river otters are 3.7 for methylmercury, 0.63 for Aroclor 1268, and 3.4 for lead when LOAEL TRVs are employed in the evaluation and an AUF of 1 is assumed. Comparable site HQs for an AUF of 0.66 are 2.4 for methylmercury, 0.43 for Aroclor 1268, and 2.3 for lead.

This single line of evidence (HQ development) suggests that there is a potential risk to piscivorous mammalian species – similar to the risk estimated for omnivorous mammals – in some areas of the marsh and Purvis Creek, particularly with the assumptions of NOAEL TRVs and an AUF of 1. For lead, the maximum NOAEL HQ (34) occurred at a sampling station (Station 33, near the old oil-processing site) where concentration of total lead in surface water was a relatively high 7.0 ug/L One of the main food items for river otters – mummichogs – at this station was characterized by body burdens of lead that averaged 26.00 mg/kg (dry wt).

<u>Assessment Endpoint 8</u> – Viability of finfishes utilizing the estuarine system, as evaluated by five measurement endpoints: 1) comparisons of concentrations of COPC in surface water to general literature-based effects levels; 2) comparisons of "whole-body" concentrations of COPC in juvenile and/or adult finfishes to general literature-based effects levels; 3) HQs derived from a food-web-exposure model for the red drum; 4) results of chronic toxicity tests conducted with early (and sensitive) life stages of finfishes; and 5) evaluation of the benthic macroinvertebrate community structure at the site (as a food source for juvenile and adult fishes).

Concentrations of total mercury in creek surface water at the LCP Site (8.0 - 420 ng/L, except 7,800 ng/L at the AB seep location) were greater than the applicable chronic ecological screening value (ESV) promulgated by Region 4 of the U. S. EPA (25 ng/L) at 11 of 28 (39%) sampling stations evaluated. Concentrations of Aroclor 1268 (<1.0 – 0.19 ug/L, except 0.52 at the AB seep location) clearly exceeded Region 4's chronic ESV for Aroclor 1254 (0.03 ug/L) at only 3 of 28 (11%) evaluated stations. Total lead concentrations (<5.0 – 7.0 ug/L, except 1,400 at the AB seep location) exceeded Region 4's chronic ESV (8.5 ug/L) only at the AB location. PAHs were detected at only 4 of 28 (14%) sampling stations evaluated. Total mercury concentrations monitored at a single sampling station (Station 5) in surface and subsurface waters over a 12-hour tidal cycle were often higher in subsurface water, and generally were positively correlated with concentrations of suspended particulate matter.

Several species of sciaenid fishes were collected in Purvis Creek. Seven silver perch (*Bairdiella chrysoura*; 113 – 195 mm total length) had mean "whole body" burdens of methylmercury and Aroclor 1268 of, respectively, 0.68 and 0.91 mg/kg (wet wt). Methylmercury values for two black drum (*Pogonias cromis*; 215 – 230 mm total length) were 0.31 and 0.41 mg/kg; while Aroclor 1268 values were 0.78 and 1.4 mg/kg. A single spotted seatrout (*Cynoscion nebulosus*; 230 mm total length) was characterized by methylmercury and Aroclor 1268 body burdens of, respectively, 0.26 and 0.25 mg/kg. All of these body burdens of Aroclor 1268 are less than a NOAEL TRV of 1.6 mg/kg (wet wt). All methylmercury body burdens are greater than a NOAEL TRV of 0.15 mg/kg (wet wt), and all but the value for the spotted seatrout exceed a LOAEL TRV of 0.30 mg/kg (wet wt).

The above-presented empirical fish data generate NOAEL HQs for Aroclor 1268 that range from 0.16 to 0.88. For fish exposed to methylmercury, NOAEL HQs range from 1.7 to 4.5, while LOAEL HQs range from 0.87 to 2.3.

In the red drum model for Aroclor 1268, mean and maximum NOAEL HQs for fish feeding on mummichogs (40% of diet), fiddler crabs (30%), and blue crabs (30%) at the site are, respectively, 2.0 and 2.7. Mean and maximum LOAEL HQs for Aroclor 1268 are, respectively, 0.21 and 0.29. For methylmercury in the red drum model, mean and maximum NOAEL HQs are, respectively, 4.9 and 7.3. Mean and maximum LOAEL HQs for methylmercury are, respectively, 2.5 and 3.7.

Toxicity tests designed to evaluate chronic toxicity of "whole" water to mysids (*Mysidopsis bahia*) and sheepshead minnows (*Cyprinidon variegatus*) generated similar results. Mean survival of mysids exposed in the laboratory to creek surface water collected from four sampling stations at the site and the two reference locations (Troup Creek and the Crescent River) ranged from 92.4 to 100%, which is greater than the minimum acceptable survival for control organisms (80%). Mean growth (weight) of mysids exposed to site and reference waters was from 0.50 to 0.84 mg (dry wt), which is greater than weight of control organisms (0.48 mg).

Survival of sheepshead minnows exposed to creek surface water obtained from the same four sampling stations at the site and two reference locations ranged from 80 to 100%, which is at least equal to the minimum acceptable survival for control organisms (80%). Mean growth (weight) of fish exposed to site water was statistically similar to weight observed for at least one reference location.

As described earlier for Assessment Endpoint 1, the benthic macroinvertebrate community evaluated in the Purvis Creek system appeared unremarkable in comparison to the communities at the reference locations with regard to the Shannon-Weaver diversity index (d) and the Lloyd-Ghelardi equitability index (e). The density of individual benthos at the four evaluated sampling stations in the creek system varied by an order-of-magnitude (from 435 to 4,500 individuals / m^2) and was sometimes less than the density observed at the reference locations (in both cases, 1,600 individuals / m^2). However, these data have limited utility for evaluating overall availability of food for finfishes in the Purvis Creek system.

The above-identified lines of evidence focus on two distinctly different types of ecological risks to finfishes utilizing the estuarine system: 1) risks to all fishes associated with direct exposure to water-borne COPC; and 2) risks to apex predators related to exposure to COPC through the food web. Regardless of the relationships between concentrations of COPC in surface water and ESVs, the more definitive measurement endpoint pertaining to results of toxicity tests indicates that there is no potential risk to finfishes via direct exposure of finfishes to COPC in surface water. Conversely, results of the empirical "body-burden" endpoint and the red drum model indicate that food-web-related accumulation of methylmercury, and possibly, Aroclor 1268, constitutes a potential risk to indigenous finfishes in the Purvis Creek system.

Risk Description

The risk description for this BERA consists of a "back-calculation" of HQs derived in food-web exposure models for selected predators and major COPC. In this theoretical exercise, HQs originally derived during risk estimation were back-calculated to unity (1), thereby identifying ecologically acceptable "body burdens" of COPC in prey of predators. These ecologically acceptable body burdens of COPC in prey were then related to associated concentrations of COPC in marsh surface sediment to estimate ecologically safe concentrations (ESCs) of COPC in the sediment.

PAHs were eliminated from this exercise because they were seldom detected in prey of predators. Similarly, inorganic mercury was not evaluated because this form of mercury was never associated with predator HQs > 1. In addition, the exercise was performed for only those predators (i. e., diamondback terrapin, clapper rail, and raccoon): 1) whose diet consisted of a substantial percentage of prey with high fidelity to surface sediment; and 2) for which a reasonable regressional relationship (or gradient) could be established between concentration of COPC in the dominant prey of predator and sediment (which occurred just for mercury species and Aroclor 1268 in fiddler crabs and marsh sediment).

The lowest ESCs of both methylmercury and Aroclor 1268 in marsh surface sediment were generated by back-calculating HQs originally developed for the raccoon after employing several simplifying exposure-related assumptions, including an AUF of 1. In the case of methylmercury, ESCs in sediment are estimated as 0.0041 mg/kg (dry wt) for LOAEL protection and 0.0028 mg/kg for NOAEL protection. For Aroclor 1268, comparable ESCs are 1.26 mg/kg (dry wt) for LOAEL protection and 0.28 mg/kg for NOAEL protection.

Comparison of the above-estimated ESCs of sedimentary methylmercury to methylmercury measured in surface sediment at 25 evaluated marsh sampling stations at the site identifies only 6 of the stations (24%) that pose no ecological risk as determined by NOAEL-associated standards, and only 8 of the stations (32%) that pose no risk according to LOAEL-related stations (64%) reflect LOAEL-related standards.

If it is assumed that the regressional relationships developed for methylmercury and Aroclor 1268 in fiddler crabs vs. marsh sediment can be projected to creek sediment, the latter type of sediment can be evaluated for ESCs of chemicals. For creek sediment and methylmercury, 21 of 32 sampling stations at the site (66%) pose no ecological risk as determined by NOAEL-associated standards, and 26 of the stations (81%) pose no risk according to LOAEL-related standards. For Aroclor 1268, only 8 of the stations (25%) reflect NOAEL-related standards, but 19 stations (59%) reflect LOAEL-related standards.

Uncertainty Analysis

The conceptual model for the BERA is believed to be characterized by minimal uncertainty. The estuary at the LCP Site has been the subject of numerous previous investigations. COPC are well known, as are exposure pathways, and biota at potential risk. The eight assessment endpoints comprehensively address the various taxonomic and trophic categories of biota that are indigenous to the estuary. Measurement endpoints employed to evaluate the assessment endpoints include, whenever possible, a combination of field, laboratory, and modeling studies. The conceptual model for the BERA is the product of numerous detailed discussions among many private and government scientists.

Implementation of the experimental design of the BERA introduced a number of mostly unavoidable uncertainties. The most basic uncertainty is the extent to which sampling data can be extrapolated to the overall estuary since all sampling was authoritative in character and, therefore, lacked a random component. Limited sample size and resulting limited precision of data was also problematic, particularly with regard to the number of sampling stations at which prey species were collected. This limitation resulted in regressional relationships between concentrations of COPC in prey vs. surface sediment to be predicated on just a few paired data points. In addition, the small number of sediment samples evaluated for toxicity (particularly amphipod toxicity) limited the ability to identify correlations between sediment chemistry and toxicity. The benthic macroinvertebrate study had an uncertain meaning.

The preponderance of uncertainty in this BERA is associated with modeling studies. In initial HQ development, obvious uncertainties pertain to selection of various exposure-related statistics (in particular, composition of predator diet and food ingestion rate) and selection of both LOAEL and NOAEL TRVs. An uncertainty of particular importance is the common use of TRVs derived from studies of Aroclor 1254 rather than the probably less toxic, site-associated Aroclor 1268.

A "hidden" uncertainty is the need to sometimes employ, in the same food-web model, prey species collected at near-by, but different, sampling stations when, in a multi-prey diet, not all prey occurred at the same sampling station. Indeed, in some cases, the total absence of a prey species for an area (i. e., insects at both reference locations; silver perch at the Crescent River reference location) precluded the development of some HQs for the area (in these cases, HQs for, respectively, the red-winged blackbird and river otter). In another case (the clapper rail model), the absence of insects at the reference locations forced a change in diet composition to a greater percentage of mummichogs. A similar uncertainty is unique to the red drum models, in which concentrations of COPC in prey collected at different sampling stations, not all of which are ideal habitat for red fish, are projected to Purvis Creek.

Substantial uncertainty is inherent in the estimation of ESCs of methylmercury and Aroclor 1268 in surface sediment by the "back-calculation" of HQs derived in food-web models for selected predators – i. e., diamondback terrapin, clapper rail, and raccoon. The sources of this uncertainty are: 1) the use of simplistic exposure assumptions (i. e., that the dominant prey species – fiddler crabs in all cases – constitutes 100% of the predator's diet; also, uptake of COPC from surface sediment and surface water are negligible and, therefore, discounted); 2) use of regression equations characterized by coefficients of determination (r^2) of less than 1 for relating body burdens of COPC in fiddler crabs to concentrations in surface sediment; 3) frequent extrapolation of regression equations beyond the limits of observed data to identify ESCs of COPC in surface sediment; 4) extrapolation of ESCs of COPC in marsh surface sediment to creek surface sediment, and 5) inability to define a reliable relationship between concentrations of methylmercury and total mercury in surface sediment and, consequently, inability to estimate an ESC of the commonly measured form of mercury.

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1. INTRODUCTION

This report presents the results of the "Site Investigation/Analysis" Phase and "Risk Characterization" Phase (Steps 6 and 7) of a baseline ecological risk assessment (BERA) conducted for the LCP Chemical Site in Brunswick, Georgia (Figure 1). Initial components of the risk assessment process – in particular, "Problem Formulation" (Step 3; Honeywell International, 2000a) and "Study Design and Data Quality Objectives" (Step 4; Honeywell International, 2000b) – are referenced, but not presented in their entirety, in this report.

The major chemicals of potential concern (COPC) addressed in the BERA are mercury (including methylmercury and inorganic mercury), Aroclor 1268, lead, and polynuclear aromatic hydrocarbons (PAHs). However, other chemicals are also evaluated in the risk assessment.

The BERA consists of two volumes. Volume I contains the most germane information in the risk assessment. It focuses on the above-identified major COPC and – in addition to bound text, figures, and tables – contains a series of plates located in a pocket inside of the back cover of the report. Volume II contains supporting information. This information includes reports from the various laboratories that participated in the investigation, an updated refined ecological screening for all COPC (not just major COPC) evaluated in the investigation, and worksheets detailing the assumptions and calculations employed in initial hazard quotient (HQ) development during the investigation.

2. SITE HISTORY

Industrial activities began at the LCP Site in 1836, when construction was initiated on an approximately 1,220-m (4,000-ft) segment of the Brunswick-Altamaha Canal that ran in a north-south direction along the interface between the upland and estuarine parts of the site. The canal eventually extended about 19 km (12 miles) from Academy Creek (Brunswick Harbor) north to the Altamaha River. The canal opened in 1854 and operated only until 1855. Waste-disposal and soil-filling activities appear to have occurred along parts of the canal that traversed the site (i. e., in the north and south disposal areas).

The Atlantic Refining Company, a predecessor of Atlantic Richfield Company (ARCO), used the site as a petroleum refinery from 1919 through 1935. The refinery processed Gulf Coast and Mexican crude oil into finished products that included light asphalt, fuel oil, lubricating oil, gas oil, kerosene, and gasoline. The boiler at the refinery was fueled by coal until 1922, after which oil was employed.

Georgia Power purchased part of the site from ARCO and operated an oil-fired power-generating facility during 1937 through 1950 that reached a generating capacity of 5,500 kW in 1941 (GeoSyntec Consultants, 1996). The Dixie Paint and Varnish Company (which eventually became the Dixie O'Brien Corporation and, subsequently, a subsidiary of the O'Brien Corporation) purchased another part of the site from ARCO in 1941, where it operated a paint and varnish manufacturing facility until 1955 (GeoSyntec Consultants, 1996)

Allied Chemical and Dye Company (the predecessor to AlliedSignal, which has now merged with Honeywell International) purchased all of the land that presently constitutes the site in 1955, with the exception of a 1.2-ha (2.9-acre) parcel still owned by Georgia Power (GeoSyntec Consultants, 1996). AlliedSignal constructed and operated a chlor-alkali facility at the site, utilizing the Solvay (mercury-cell) process. Primary products of the chlor-alkali operation were chlorine gas, hydrogen gas, and sodium-hydroxide solution.

LCP Chemical-Georgia (which became a division of the now defunct Hanlin Group, Inc.) purchased all of AlliedSignal's part of the site in 1979 and continued to operate the chlor-alkali facility (GeoSyntec Consultants, 1996). LCP discontinued the chlor-alkali operation in 1994.

3. PROCEDURES

Procedures employed in the BERA for the LCP Site were designed to address the following fundamental assessment and measurement endpoints, which were originally developed in, respectively, the "Problem Formulation" Phase (Honeywell International, 2000a) and "Study Design and Data Quality Objectives" Phase (Honeywell International, 2000b) of the BERA.

Assessment Endpoint 1 – Viability of the benthic estuarine community specifically in terms of structure and function, as evaluated by three measurement endpoints: 1) comparisons of concentrations of COPC in surface sediment to general literature-based effects levels; 2) results of chronic toxicity tests conducted with sensitive life stages of benthic aquatic life; and 3) evaluation of the benthic macroinvertebrate community structure at the site.

Assessment Endpoint 2 – Viability of omnivorous reptiles utilizing the marsh and Purvis Creek, as evaluated by three measurement endpoints: 1) comparisons of concentrations of COPC in eggs of diamondback terrapins (*Malaclemys terrapin*) captured at the site to general literature-based effects levels; 2) hazard quotients (HQs) derived from a food-web exposure model for the terrapin; and 3) results of histopathology examinations (e. g., liver and neural abnormalities) of terrapins captured at the site.

Assessment Endpoint 3 – Viability of omnivorous avian species utilizing the marsh and Purvis Creek, as evaluated by four measurement endpoints: 1) comparisons of concentrations of COPC in livers of clapper rails (*Rallus longirostris*) captured at the site to general literature-based effects levels; 2) HQs derived from a food-web exposure model for the red-winged blackbird (*Agelaius phoeniceus*); 3) HQs derived from a food-web exposure model for the clapper rail; and 4) results of histopathology examinations (e. g., liver and neural abnormalities) of clapper rails captured at the site.

Assessment Endpoint 4 – Viability of piscivorous avian species utilizing the marsh and Purvis Creek, as evaluated by four measurement endpoints: 1) comparisons of concentrations of COPC in livers of clapper rails captured at the site to general literature-based effects levels; 2) HQs derived from a food-web exposure model for the green heron (*Butorides striatus*); 3) results of histopathology examinations (e. g., liver and neural abnormalities) of clapper rails captured at the site; and 4) results of a survey of abundance of wading birds in the area.

Assessment Endpoint 5 – Viability of herbivorous mammalian species utilizing the marsh and Purvis Creek, as estimated by HQs derived from a food-web exposure model for the marsh rabbit (*Sylvilagus palustris*).

Assessment Endpoint 6 – Viability of omnivorous mammalian species utilizing the marsh and Purvis Creek, as estimated by HQs derived from a food-web exposure model for the raccoon (*Procyon lotor*).

Assessment Endpoint 7 – Viability of piscivorous mammalian species utilizing the marsh and Purvis Creek, as estimated by HQs derived from a food-web exposure model for the river otter *(Lutra canadensis)*.

Assessment Endpoint 8 – Viability of finfishes utilizing the estuarine system, as evaluated by five measurement endpoints: 1) comparisons of concentrations of COPC in surface water to general literature-based effects levels; 2) comparisons of "whole-body" concentrations of COPC in juvenile and/or adult finfishes to general literature-based effects levels; 3) HQs derived from a food-web-exposure model for the red drum (*Sciaenops ocellatus*); 4) results of chronic toxicity tests conducted with early (and sensitive) life stages of finfishes; and 5) evaluation of the benthic macroinvertebrate community structure at the site (as a food source for juvenile and adult fishes).

The site investigation designed to address the above-identified assessment and measurement endpoints was conducted during the period of October 10 – 19, 2000. The site was arbitrarily divided into three major sections (southern, northern, and western parts), which extended from upper Purvis Creek to the Turtle River (in a northerly-to-southerly direction) and from the shoreline to the western boundary of Purvis Creek (in an easterly-to-westerly direction). Sampling stations were then authoritatively established in creek (Figures 2 and 3) and marsh (Figure 4) environments in each of the sections.

A total of 52 sampling stations (46 "regular" stations, 5 stations in a previously remediated "marsh grid," and 1 shoreline station where seepage of fluids was observed) was established throughout the site. Two reference locations – one at Troup Creek and the other in the Crescent River – were also established. Sampling stations were selectively evaluated for surface water chemistry, chronic toxicity of surface water, surface sediment (from 0 to 15 cm in depth) chemistry, chronic toxicity of surface sediment, surface sediment biota (community characteristics of benthic macroinvertebrates), and body burdens (concentrations) of major COPC in "whole bodies" of a variety of biota (i. e., cordgrass, fiddler crabs, insects, mummichogs, blue crabs, and several sciaenid fishes including silver perch).

The basic experimental design for the above-described studies (Table 1) reflects a work plan (Honeywell International, 2000c) and a series of subsequent modifications (in particular, EPA 2000a, 2000b, 2000c, 2000d) partially developed and approved in their entirety by Region 4 of the U. S. Environmental Protection Agency (U. S. EPA). Several adjustments to the work plan and subsequent modifications were dictated by conditions encountered in the field. Adjustments approved by Region 4 (e. g., Graff, 2000) include: 1) relocation of a series of sampling stations (Stations 33 and 40) to a more easterly position; 2) relocation of another sampling station (Station 25) to a near-by position in the main canal; 3) relocation of all fiddler-crab (*Uca* spp.) and mummichog (*Fundulus heteroclitus*) sampling stations to suitable habitats; 4) substitution of mud crabs for fiddler crabs if necessary; 5) evaluation of COPC and suspended particulate matter in creek surface and subsurface waters at a single sampling station (Station 5) during a 12-hour tidal cycle, as contrasted to an originally planned 24-hour period; 6) reduction in the number of sampling positions at two of three transect sampling stations for creek surface sediment (Stations 6 and 11) from the originally planned nine locations to seven locations; 7) inability to collect insects (a prey species employed in food-web modeling) at the reference locations; 8) inability to collect red drum at any sampling location; and 9) substitution of silver perch (*Bairdiella chrysoura*) caught by fishermen for red drum in Purvis Creek (silver perch were collected by net at the Troup Creek reference location, but could not be collected at the Crescent River reference location).

The only major laboratory-related deviation from the work plan and subsequent modifications was the failure of 5 of 11 toxicity tests conducted with amphipods (*Leptocheirus plumulosus*) exposed to surface sediment from the site and the Crescent River reference location. In addition, the laboratory that performed the grass shrimp (*Palaemonetes pugio*) toxicity tests elected to evaluate survival and reproduction of shrimp, but not reversible DNA aberrations by the Comet assay.

The above-referenced primary studies at the site were supplemented by results of several previously conducted studies. These secondary studies consisted of evaluations of COPC in eggs of diamondback terrapins captured at the site, histopathology examinations of indigenous diamondback terrapins and clapper rails, evaluations of COPC in livers of indigenous clapper rails, and a survey of wading birds in the area. Procedures employed in these investigations are detailed in Appendix A of Volume II of this report.

4. BACKGROUND (HISTORICAL ECOLOGICAL INVESTIGATIONS)

A number of investigations conducted at the LCP Site have been reported in peer-reviewed scientific literature. Gardner et al. (1978) reported that total mercury concentrations in various biological components of the marsh ecosystem (including specific organs of biota) at the LCP Site ranged from <1 to 60 mg/kg (dry wt) in the period of 1974-76. Methylmercury concentrations were low (<0.002 mg/kg) in sediment and plants, but accounted for most of the mercury in higher organisms. Windom et al. (1976) noted that the annual production of methylmercury in the upper 5 cm of sediment at the site may approximate 50 ug per gram of total mercury.

Kurunthachalam et al. (1997) reported concentrations of total polychlorinated biphenyls (PCBs) between 9.6 and 567 mg/kg (dry wt) in soil and marsh sediment at the LCP Site in, presumably, the mid-1990s. The PCBs, which appeared to be Aroclor 1268, declined 100-fold with distance from the site, which was reported to suggest a high attenuation and stability of the chemical in the marsh environment. Maruya and Lee (1998) identified mean biota-sediment accumulation factors (BSAFs) of the 15 most abundant congeners of Aroclor 1268 at the site to be 0.28, 0.81, and 3.1, respectively, for grass shrimp, spotted seatrout, and young-of-year striped mullet (the latter being a species that often forages just above the sediment). Kurunthachalam et al. (unknown date) noted that bioaccumulation of superhydrophobic congeners of Aroclor 1268 in blue crabs, finfishes, diamondback terrapin, and birds was less than would be predicted from K_{ow} partitioning, thereby supporting the hypothesis that these compounds have restricted membrane permeability.

Toxicity of sediments and associated pore water collected from the LCP Site in 1990 was evaluated by Winger at al. (1993). Pore water extracted from sediment at several locations near the LCP discharge was highly toxic as determined by bacterial (Microtox®) testing. In addition, 10-day tests with pore water and whole sediment from these locations indicated high toxicity to amphipods (*Hyalella azeteca*). The authors attributed observed toxicity to PCBs and, possibly, methylmercury, although other metals were present in the sediment.

Recent field investigations of aquatic biota at the LCP Site (Wall et al., 2001) have provided only suggestive evidence for impacts at lower trophic levels – i. e., on smooth cordgrass (*Spartina alterniflora*), bacteria, and grass shrimp – although grass shrimp reproduction appeared to be negatively affected. Indeed, Newell et al. (2000) ~~noted that smooth~~ cordgrass and associated fungi (which are the main drivers of cordgrass decomposition) appear to be resistant to poisoning by anthropogenic agents. However, these authors cautioned that, unless resistance mechanisms involve degradation of toxicants, cordgrass and fungi may have the potential to readily move toxicants into the food web.

Finally, an investigation conducted in 1995 (Horne et al., 1999) addressed several measurements of ecological stress at the LCP Site. Total mercury concentrations in sediment ranged from 15 to 170 mg/kg (dry wt), while concentrations of Aroclor 1268 varied from 2.3 to 150 mg/kg (dry wt). Standard 14-day toxicity tests with amphipods (*Leptocheirus plumulosus*) exposed to sediment from five evaluated sampling stations indicated absence of acute toxicity. Density of individual benthic invertebrate species showed no consistent patterns in response to pollutants. However, nematodes and oligochaetes were characteristic of uncontaminated areas, while polychaetes were dominant in contaminated areas. In addition, uncontaminated areas were characterized by an evenly distributed percentage of surface and subsurface feeders, while contaminated areas were dominated by surface feeders. Mercury and PCBs were reported to be bioaccumulating in representative marsh benthic invertebrates, thereby posing a potential threat to marsh consumers.

In the remaining part of this section of the report, non-peer-reviewed ecological investigations specific to the LCP Site are reviewed.

4.1 U. S. Environmental Protection Agency

The U. S. EPA (Sprenger et al., 1997) conducted three ecological studies of the LCP Site in 1995 that are particularly relevant to the present investigation.

4.1.1 Acute Sediment Toxicity Study

In addition to the above-described peer-reviewed 14-day toxicity tests with amphipods, acute toxicity tests were also conducted with brown shrimp (*Penaeus vannamei*) and Japanese medaka (*Oryzias latipes*) embryos exposed to control sediment as well as sediment from four locations at the LCP Site and a reference area.

The brown shrimp tests (10-day tests) revealed no behavioral differences between shrimp exposed to any of the test sediments (including reference and control sediments). In addition, there was no statistical difference ($P < 0.05$) in survival among all treatments. Mean survival of shrimp exposed to sediment from the site ranged from 97 to 100%, as contrasted to reference and control survival of, respectively, 94 and 97%.

The Japanese medaka embryo test documented slightly lower survival (89 to 90%) in organisms exposed to three of four sediments from the site, as compared to 100% survival for the other site sediment, reference sediment, and control sediment. Hatching of embryos was delayed in all test sediments except the control. However, the authors of the study focused on the embryonic lesions that occurred at a higher frequency in site sediments (2 to 8 lesions) vs. reference (1 lesion) and control (0 lesions) sediments. The authors noted that the observed lesions are "consistent" with lesions known to be associated with dioxins, furans, PCBs, and, possibly, mercury.

4.1.2 Diamondback Terrapin Body-Burden and Histopathology Study

Eight mature diamondback terrapins (*Malaclemys terrapin*) were collected in the marsh system at the LCP Site during May and July of 1995, when females were actively nesting. Food items found in the guts of the terrapins consisted of fiddler crabs and marsh periwinkles. Although body burdens (concentrations) of mercury and Aroclor 1268 were evaluated in the carcasses, brains, livers, eggs, and hatchlings of the terrapins, emphasis was directed at the eggs and hatchlings of three female terrapins.

These three female terrapins were characterized by the following mean concentrations of mercury and Aroclor 1268 in their eggs (expressed as dry wt) – Female 1 (BD1): 0.87 mg/kg mercury and 29.7 mg/kg Aroclor 1268; Female 2 (DD4): 2.2 mg/kg mercury and 28.6 mg/kg Aroclor 1268; and Female 3 (DD5): 4.6 mg/kg mercury and 480 mg/kg Aroclor 1268. Although eggs from Female 2 did not hatch, eggs from the other females – which contained higher concentrations of mercury (Female 3) and Aroclor 1268 (Females 1 and 3) – did hatch.

In this same study, histopathology examination of terrapins did not indicate any degeneration or abnormality known to be associated with the COPC.

4.1.3 Clapper Rail Body-Burden and Histopathology Study

Seven clapper rail (*Rallus longirostris*) averaging 276.6 g (wet wt) in weight were collected from the southern part of the LCP Site. Although body burdens (concentrations) of mercury and Aroclor 1268 were evaluated in the carcasses, livers, breast muscle, and feathers of the birds, only mercury in livers was associated with a level reported to be harmful to birds.

The mean mercury concentration in livers of the seven birds was 3.84 mg/kg (wet wt). (The mean concentration of Aroclor 1268 was 25.2 mg/kg [dry wt]). However, mercury concentrations in bird livers was reported to be associated with avian mortality at levels of (all values expressed in terms of wet weight) 126.5 mg/kg (red-winged blackbirds), 54.5 mg/kg (grackles), and 4.6 to 91 mg/kg (white-tailed eagles).

In this same study, histopathology examination did not indicate specific toxicity or specific uniform degeneration of tissues of clapper rails. In particular, myelin sheath and axonal degeneration, characteristic of mercury toxicity, were not observed except in one case, which may have been an artifact. Also, liver necrosis and fatty change, typical of PCB toxicity, were not noted.

4.2. PTI and CDR Environmental Specialists – Wading Bird Survey

PTI and CDR Environmental Specialists (1998) conducted a wading bird study (consisting of 40 aerial flights) at the LCP Site during the period of June through mid-December of 1996. A parallel study was also conducted at a reference site (Hawkins Creek).

Six species of wading birds were observed at both sites. Great egrets (*Casmerodius albus*), snowy egrets (*Egretta thula*), and wood storks were most commonly observed. Great blue herons (*Ardea herodia*) were consistently present, but in low numbers. White ibis (*Eudocimous* *albus*) and little blue herons (*Egretta caerulea*) were occasionally observed in high numbers, but their presence during surveys was infrequent.

The three dominant wading bird species (great egrets, snowy egrets, and wood storks) and all six species combined were present in significantly higher numbers during low tides than high tides at both sites. The birds used tidal creeks almost exclusively, with few observations recorded in the vegetated marsh. Wood storks were typically found in the smaller intertidal creeks, the confluence of those creeks with larger-order creeks, and mud flat openings at the origins of the first-order creeks.

Most wading birds were observed at the extreme northern boundary of the LCP Site (including tributaries of the Turtle River), far distant from the areas of greatest contamination by COPC.

5. ECOLOGICAL EXPOSURE AND EFFECTS EVALUATION

This section of the report addresses the presence of major COPC in environmental media at the LCP Site, chronic toxicity of environmental media, and characteristics of the benthic macroinvertebrate community.

5.1 Presence of Major Chemicals of Potential Concern in Environmental Media

Surface water, surface sediment, and biota at the site are sequentially evaluated.

5.1.1 Surface Water

General water quality characteristics of creek surface water at the LCP Site were unremarkable for the time of the field study and similar to characteristics observed at the reference locations (Table 2).

Concentrations of total mercury in creek surface water at the site (8.0 - 420 ng/L, except 7,800 ng/L at the AB seep location) were greater than the applicable chronic ecological screening value (ESV) promulgated by Region 4 of the U. S. EPA (25 ng/L) at 11 of 28 (39%) sampling stations evaluated (Table 3). Methylmercury concentrations typically constituted from <0.10 to ~3% of total mercury values, but reached a maximum of 21% at Station 30. Concentrations of both forms of mercury at reference locations were always less than concentrations at the site.

Relationships between total mercury and methylmercury concentrations in creek surface water are not well defined, as reflected by coefficients of determination (r^2) ranging from 0.36 to 0.69 (Figure 5; excluding the AB seep location). (Values of r^2 indicate the amount of variation in one variable [in this case methylmercury] that can be explained in terms of variation in the other variable [i. e., total mercury].)

Concentrations of Aroclor 1268 at the site (<1.0 – 0.19 ug/L, except 0.52 ug/L at the AB seep location) clearly exceeded Region 4's chronic ESV for Aroclor 1254 (0.03 ug/L) at only 3 of 28 (11%) evaluated stations (Table 3). Total lead concentrations at the site (<5.0 – 7.0 ug/L, except 1.400 ug/L at the AB seep location) exceeded Region 4's chronic ESV (8.5 ug/L) only at the AB location. PAHs were detected at only 4 of 28 (14%) sampling stations evaluated.

Total mercury concentrations monitored at a single sampling station (Station 5; at the mouth of the main canal at the LCP Site) in surface and subsurface waters over a 12-hour tidal cycle were often higher in subsurface water, and generally were positively correlated with concentrations of suspended particulate matter (Figures 6 and 7).

Total mercury, Aroclor 1268, and total lead concentrations in creek surface water at the LCP Site are presented on a station-specific basis in, respectively, Plates 1, 2, and 3 of this report.

.1.2 Surface Sediment

'oncentrations of total mercury (0.048 - 110 mg/kg, dry wt) and Aroclor 1268 (0.015 - 23 ng/kg) in creek surface sediment at the LCP Site were almost always greater than applicable cological effects values (EEVs; 0.13 mg/kg for total mercury and 0.0216 mg/kg for total PCBs) romulgated by Region 4 of the U. S. EPA (Table 4). Lead (3.7 - 1,100 mg/kg) was sometimes levated above Region 4's EEV (30.2 mg/kg), and total PAHs (0 - 17 mg/kg) were seldom levated over their EEV (1.684 mg/kg).

Values for r^2 for the relationships between total mercury and methylmercury concentrations in creek surface sediment were low except in the case of the polynomial relationship ($r^2 = 0.70$), which could be explained, in part, by mortality of methylating bacteria at high concentrations of total mercury (Figure 8). Patterns of total mercury and Aroclor 1268 contamination appeared dissimilar (Figure 9). No consistent patterns of mercury or Aroclor 1268 concentrations were observed in surface sediment collected at various locations along three transects extending across the creek system into the marsh (Figure 10).

For marsh surface sediment at the site, the same above-described general relationships were observed between concentrations of total mercury (0.12 - 63 mg/kg, dry wt) and lead (2.4 - 120 mg/kg) vs. applicable EEVs (Table 5). However, concentrations of Aroclor 1268 (0.043 - 4.9 mg/kg) always exceeded the EEV for total PCBs; and levels of total PAHs (0 - 1.4 mg/kg) were never elevated above their EEV.

A suggestion of the polynomial relationship described above for mercury species in creek surface sediment was observed for marsh surface sediment (Figure 11). (The unusual negative notation for the r^2 for the linear relationship is an artifact of forcing the regression line through the origin of the graph, which, although logical, is contrary to the pattern of the data.) Patterns of total mercury and Aroclor 1268 contamination in marsh surface sediment were more similar than in the case of creek surface sediment (Figure 12), which could be a function of lesser opportunity for dispersal and/or degradation of the two COPC in the marsh environment.

Total mercury, Aroclor 1268, lead, and total PAH concentrations in creek surface sediment at the LCP Site are presented on a station-specific basis in, respectively, Plates 4, 5, 6, 7, and 8 of this report. (Two methods are employed to address PAH concentrations; refer to Footnote "e" in Table 4.)

Total mercury, Aroclor 1268, lead, and total PAH concentrations in marsh surface sediment at the LCP Site are presented on a station-specific basis in, respectively, Plates 9, 10, 11, 12, and 13 of this report. (The two methods employed to address PAH concentrations are referenced in Footnote "e" in Table 5.)

5.1.3 Biota

Mean body burdens (concentrations) of total mercury, methylmercury, and inorganic mercury in all biota collected from the LCP Site were elevated in comparison to mean concentrations at reference locations (Table 6). For Aroclor 1268, the same was true except in the case of cordgrass. In the case of lead, mean concentrations in site biota were only occasionally elevated above reference values. However, lead concentrations in fiddler crabs from the AB seep location and in mummichogs from Station 33 were dramatically high. In a lesser number of cases, concentrations of COPC at site stations appeared to be statistically elevated as contrasted to concentrations at reference locations.

Lipid content of biota from the site did not appear to be remarkable in comparison to levels in reference biota (Table 6).

5.2 Chronic Toxicity of Environmental Media

Chronic toxicity of surface water and surface sediment are sequentially assessed.

5.2.1 Surface Water

Mysids (*Mysidopsis bahia*) and sheepshead minnows (*Cyprinodon variegatus*) were evaluated for chronic toxicity of surface water.

5.2.1.1 Mysids

Mean survival of mysids exposed in the laboratory for 7 days to creek surface water collected from four sampling stations at the LCP Site and the two reference locations (Table 7) ranged from 92.4 to 100%, which is greater than the minimum acceptable survival for control organisms (80%). Mean growth (weight) of mysids exposed to site and reference waters was from 0.50 to 0.84 mg (dry wt), which is greater than weight of control organisms (0.48 mg).

5.2.1.2 Sheepshead Minnows

Survival of sheepshead minnows exposed for 7 days to creek surface water obtained from the same four sampling stations at the LCP Site and two reference locations (Table8) ranged from 80 to 100%, which is greater than the minimum acceptable survival for control organisms (80%). Mean growth (weight) of fish exposed to site water was statistically similar to weight observed for at least one reference location and, except for Station 33, the control.

5.2.2 Surface Sediment

Amphipods and grass shrimp were evaluated for chronic toxicity of surface sediment.

5.2.2.1 Amphipods

Mean survival of amphipods exposed in the laboratory for 28 days to cheek surface sediment collected from five sampling stations in the marsh grid at the LCP Site and at the Troup Creek reference location was significantly lower at Stations K7 and H7 than at the other stations and the control (Table 9). Survival of amphipods exposed to sediment from several stations in the marsh grid (Stations B7, D9, and N2) was greater than, although statistically similar to, survival of organisms presented to sediment from the Troup Creek reference location.

5.2.2.2 Grass Shrimp

Mean survival of grass shrimp exposed in the laboratory for 2 months to cheek surface sediment collected from nine sampling stations in the marsh grid and estuarine system at the LCP Site and at both reference locations was generally statistically similar (Table 10; Part A). However, shrimp survival for Station 16, although similar to survival for the Troup Creek reference location, was less than survival for the Crescent River reference location.

Various measures of grass shrimp reproduction (Table 10; Parts B, C, and D), although not implicating sediment from Station 16 as a major cause of impaired reproduction, tended to isolate two sampling stations in the marsh grid (Stations H7 and K7), as well as three stations in the Purvis Creek system (Stations 5, 7, and to a lesser degree, 33) as causes of impaired reproduction. It is noteworthy that sediment from Stations H7 and K7 proved toxic to both grass shrimp, an epifaunal benthos, as well as to the previously discussed amphipods, which are infaunal benthos.

Chemical causes of observed toxicity are often difficult to identify. In the case – involving both amphipods and grass shrimp (Table 11) – linear coefficients of determination (r^2) for mercury and Aroclor 1268 in sediment vs. sediment toxicity were either low or, in many cases, documented an "opposite relationship." Alternatively stated, increased sediment toxicity was associated with decreased sedimentary concentrations of mercury and Aroclor 1268. Consequently, these two COPC cannot be implicated as causes of sediment toxicity.

The highest r^2 values for COPC in sediment and amphipod toxicity (Table 11) occurred for lead ($r^2 = 0.42 - 0.54$) and total PAHs ($r^2 = 0.55 – 0.56$). For grass shrimp, the highest r^2 values were also noted for lead in sediment vs. percent of surviving females producing embryos ($r^2 = 0.69$) and percent of embryos hatching ($r^2 = 0.54$). Other chemicals were or may have been present in sediment tested for toxicity and cannot be discounted as contributing to observed toxicity.

5.3 Characteristics of Benthic Macroinvertebrate Community

The benthic macroinvertebrate community evaluated in the Purvis Creek system at the LCP Site appeared unremarkable in comparison to the communities at the reference locations (Table 12) with regard to the Shannon-Weaver diversity index (d) and the Lloyd-Ghelardi equitability index (e). The density of individual benthos at the four evaluated sampling stations in the creek system varied by an order-of-magnitude (from 435 to 4,500 individuals / m^2) and was sometimes less than the density observed at the reference locations (in both cases, 1,600 individuals / m^2).

The only oligochaetes observed in the study were tubificids, which occurred at all sampling stations except the Troup Creek reference location. Nematodes, which also have been reported to be indicative of uncontaminated areas (Horne et al., 1999), were not observed at any sampling station.

5.4 Development of Hazard Quotients for Predators

HQs based on food-web modeling were developed for eight predators – red drum, diamondback terrapin, red-winged blackbird, clapper rail, green heron, marsh rabbit, raccoon, and river otter – that might frequent the LCP Site. HQs for wildlife were intended to formally address exposure all five major COPC – inorganic mercury, methylmercury, Aroclor 1268, lead, and PAHs. HQs for red drum are to address just methylmercury and Aroclor 1268.

A modification to these plans was made when, as generally expected, only 3 PAHs were detected out of 1,343 total PAHs measured in prey collected at the site (Appendix C.1.2 of Volume II of report). Two of these three detected concentrations of PAHs (14 mg/kg acenaphthene + 8.9 mg/kg pyrene = 22.9 mg/kg [dry wt]) occurred in one of seven replicates (Replicate 4) of blue crabs collected from upper Purvis Creek. If this one value (22.9 mg/kg) is employed as the sole measure of PAH uptake ("undiluted" by the other six replicates and not considering uptake from sediment or water) by wildlife that feed on blue crabs, resulting NOAEL HQs would be: 0.098 (green heron), 0.56 (raccoons), and 0.11 (river otters). (The exposure assumptions and TRVs on which these and other HQs are based are presented in, respectively, Tables 13 and 14.)

The basic equation used to calculate HQs is:

$$HQ = \frac{[[(CP1 \times D1) + (\ldots \times \ldots) + (CP4 \times D4)]\,[FIR] + [CS]\,[SIR] + [CW]\,[WIR]]\,[TUF]\,[AUF] / BW}{TRV}$$

with CP1, ..., CP4 = concentrations of COPC in various prey species (mg/kg, dry wt); D1, ..., D4 = percentage of each prey species in diet of predator (total for all prey species = 1); FIR = food (prey) ingestion rate (kg dry wt / day); CS = concentration of COPC in sediment (mg/kg, dry wt); SIR = sediment ingestion rate (kg dry wt / day); CW = concentration of COPC in water (mg / L); WIR = water ingestion rate (L / day); TUF = time-use factor; AUF = area-use factor; BW = body weight of predator (kg / wet wt); and TRV = toxicity reference value (mg / kg BW / day.

Mean and maximum HQs are sequentially presented for predators exposed to major COPC.

5.4.1 Mean Hazard Quotients

Mean HQs for predators (Table 15) are based on the exposure assumptions and TRVs presented in, respectively, Tables 13 and 14. The concentrations of COPC in prey of predators are the mean concentrations originally presented in Table 6. Worksheets presenting detailed calculations of these HQs are contained in Appendix I of Volume II of this report.

The red drum methylmercury model is the only major component of the BERA that has not yet been completed. In addition, the Aroclor 1268 model has not yet been applied to the reference locations. These results will be submitted to Region 4 in the form of revised pages by June 8. Mean HQs for red drum exposed to Aroclor 1268 are 2.0 (NOAEL HQ) and 0.21 (LOAEL HQ).

No HQs (LOAEL or NOAEL HQs) for diamondback terrapins are greater than unity (1). For birds, the only HQ > 1 for red-winged blackbirds is a NOAEL HQ (1.4) for lead at Station 26.

Clapper rails are characterized by an elevated NOAEL HQ for methylmercury (1.2) at the "AB" seep location. In addition, a substantially elevated NOAEL HQ (10) characterizes clapper rails exposed to lead at the "AB" seep location.

Green herons exhibit an elevated LOAEL HQ (1.3) for methylmercury at Station 9 and elevated NOAEL HQs (1.3 – 2.5) for methylmercury at all evaluated site stations. For green herons and lead, a NOAEL HQ of 10 characterizes Station 33.

In the case of mammals, the marsh rabbit is characterized by numerous LOAEL and NOAEL HQs for lead that are greater than 1. However, only the NOAEL HQ (22) for lead at Station 40 is substantially greater than corresponding HQs (6.9 – 9.7) for the reference locations.

For raccoons and an AUF of 1, LOAEL HQs (1.7 – 2.1) and NOAEL HQs (2.9 –3.6) for methylmercury are elevated at all evaluated site stations. Under this same set of circumstances, NOAEL HQs (1.2 – 3.3) for Aroclor 1268 are elevated at all site stations. For raccoons and lead, a substantially elevated NOAEL HQ (41) characterizes the "AB" seep location.

For river otters and an AUF of 1, LOAEL HQs (2.6 – 2.8) and NOAEL HQs (4.3 – 4.8) for methylmercury are elevated at all evaluated site stations. Under this same set of circumstances, NOAEL HQs (3.1 – 4.0) for Aroclor 1268 are elevated at all site stations. For river otters and lead, a substantially elevated NOAEL HQ (14) characterizes Station 33.

5.4.2 Maximum Hazard Quotients

Maximum HQs for predators (Table 16) are predicated on the same tables (Tables 6, 13, and 14) and Appendix (Appendix I) identified above for mean HQs. However, in this case, the concentrations of COPC in prey of predators are defined as the upper limit of the 95% confidence interval or the highest measured concentration of COPC, whichever is less (Table 6). In addition, maximum HQs are not presented for inorganic mercury because mean NOAEL HQs for this species of mercury (Table 15) are 2 to 5 orders-of-magnitude less than unity (1), and maximum HQs would clearly not exceed unity.

The red drum methylmercury model is the only major component of the BERA that has not yet been completed. In addition, the Aroclor 1268 model has not yet been applied to the reference locations. These results will be submitted to Region 4 in the form of revised

pages by June 8. Maximum HQs for red drum exposed to Aroclor 1268 are 2.6 (NOAEL HQ) and 0.27 (LOAEL HQ).

No HQs (LOAEL or NOAEL HQs) for diamondback terrapins are greater than unity (1).

For birds, the only HQ > 1 for red-winged blackbirds is a NOAEL HQ (1.4) for lead at Station 26.

Clapper rails are characterized by an elevated NOAEL HQ for methylmercury (1.3) at the "AB" seep location. In addition, a substantially elevated NOAEL HQ (12) characterizes clapper rails exposed to lead at the "AB" seep location.

Green herons exhibit an elevated LOAEL HQ (1.4) for methylmercury at Station 9 and elevated NOAEL HQs (1.5 – 2.8) for methylmercury at all evaluated site stations. For green herons and lead, a NOAEL HQ of 27 characterizes Station 33.

In the case of mammals, the marsh rabbit is characterized by numerous LOAEL and NOAEL HQs for lead that are greater than 1. However, only the NOAEL HQ (28) for lead at Station 40 is substantially greater than corresponding HQs (7.8 – 13) for the reference locations.

For raccoons and an AUF of 1, LOAEL HQs (2.3 – 2.8) and NOAEL HQs (3.9 –4.7) for methylmercury are elevated at all evaluated site stations. Under this same set of circumstances, NOAEL HQs (1.6– 5.0) for Aroclor 1268 are elevated at all site stations. For raccoons and lead, a substantially elevated NOAEL HQ (47) characterizes the "AB" seep location.

For river otters and an AUF of 1, LOAEL HQs (3.6 – 3.7) and NOAEL HQs (6.0 – 6.2) for methylmercury are elevated at all evaluated site stations. Under this same set of circumstances, NOAEL HQs (5.0 – 6.3) for Aroclor 1268 are elevated at all site stations. For river otters and lead, a substantially elevated NOAEL HQ (34) characterizes Station 33.

The frequency of occurrence of elevated maximum NOAEL HQs at site stations (Table 17) ranges from 0% (all predators exposed to inorganic mercury; red-winged blackbirds exposed to methylmercury and Aroclor 1268 ; clapper rails and green herons exposed to exposed to Aroclor 1268; and marsh rabbits exposed to methylmercury) to 100% (red fish exposed to Aroclor 1268 (**methylmercury data pending**); green herons exposed to methylmercury; raccoons and river otters exposed to methylmercury and Aroclor 1268; and all predators evaluated for lead).

6. RISK CHARACTERIZATION

This section of the report consists of a risk estimation for COPC in environmental media at the LCP Site, a risk description, and an uncertainty analysis.

6.1 Risk Estimation

This risk estimation addresses each of the eight previously identified assessment endpoints by integrating, in a "strength-of-evidence" approach, results of the various measurement endpoints (lines of evidence or studies) presented in Section 5 of this report. These measurement endpoints are addressed according to their generally increasing ecological significance.

6.1.1 Benthic Estuarine Community (Assessment Endpoint 1)

Concentrations of total mercury (0.048 - 110 mg/kg, dry wt) and Aroclor 1268 (0.015 - 23 mg/kg) in creek surface sediment at the LCP Site were almost always greater than applicable EEVs (0.13 mg/kg for total mercury and 0.0216 mg/kg for total PCBs) promulgated by Region 4 of the U. S. EPA. Lead (3.7 - 1,100 mg/kg) was sometimes elevated above Region 4's EEV (30.2 mg/kg), and total PAHs (0 - 17 mg/kg) were seldom elevated over their EEV (1.684 mg/kg). No consistent patterns of mercury or Aroclor 1268 concentrations were observed in surface sediment collected at various locations along three transects extending across the creek system into the marsh.

For marsh surface sediment at the site, the same above-described general relationships were observed between concentrations of total mercury (0.12 - 63 mg/kg, dry wt) and lead (2.4 - 120 mg/kg) vs. applicable EEVs. However, concentrations of Aroclor 1268 (0.043 - 4.9 mg/kg) always exceeded the EEV for total PCBs; and levels of total PAHs (0 - 1.4 mg/kg) were never elevated above their EEV.

Chronic toxicity tests with amphipods and grass shrimp exposed in the laboratory to creek surface sediment generated similar results. Survival of amphipods exposed to sediment from the site was significantly lower than survival of reference (Troup Creek) organisms at only two sampling stations (Stations K7 and H7) out of five sampling stations evaluated in the marsh grid. Survival of grass shrimp at these two sampling stations and at seven other stations in the marsh grid and Purvis Creek system usually was not significantly lower than survival of reference organisms. However, these two sampling stations, as well as three out of four stations in the Purvis Creek system (Stations 5, 7, and 33), were characterized by impaired reproductive processes of shrimp.

The highest linear r^2 between chemistry of sediment and amphipod toxicity occurred for lead (r^2 = 0.42 - 0.54) and total PAHs (r^2 = 0.55 – 0.56). For grass shrimp, the highest r^2 values were also noted for lead in sediment vs. percent of surviving females producing embryos (r^2 = 0.69) and percent of embryos hatching (r^2 = 0.54).

The benthic macroinvertebrate community at the four stations that were evaluated in the Purvis Creek system (Stations 5, 7, 16, and 33) appeared unremarkable in comparison to the communities at the reference locations with regard to the Shannon-Weaver diversity index (d) and the Lloyd-Ghelardi equitability index (e).

The first two of the above-identified lines of evidence (sediment chemistry evaluations and toxicity tests) indicate that there is a potential risk to the structure and function of the benthic estuarine community at selected locations at the LCP Site. The above-referenced r^2 values indicate that this risk is more associated with sedimentary lead and PAHs, rather than mercury or Aroclor 1268. The risk may be greatest to environmentally naïve benthos (as evidenced by results of the chronic toxicity tests) as contrasted to environmentally acclimated benthos (as judged by the study of the benthic macroinvertebrate community at the site).

6.1.2 Omnivorous Reptiles (Assessment Endpoint 2)

In a study conducted in 1995, the eggs from three female diamondback terrapins obtained from the site were characterized by mean concentrations of the following COPC (all egg concentrations expressed as dry wt) – Female 1 (BD1): 0.87 mg/kg mercury and 29.7 mg/kg Aroclor 1268; Female 2 (DD4): 2.2 mg/kg mercury and 28.6 mg/kg Aroclor 1268; and Female 3 (DD5): 4.6 mg/kg mercury and 480 mg/kg Aroclor 1268. Although eggs from Female 2 did not hatch, eggs from the other females – which contained higher concentrations of mercury (Female 3) and Aroclor 1268 (Females 1 and 3) – did hatch. Consequently, elevated concentrations of mercury and Aroclor 1268 in terrapin eggs (even levels that existed in 1995) cannot be implicated as causing failed reproduction in terrapins.

In the same above-referenced diamondback terrapin study, histopathology examination did not indicate any degeneration or abnormality known to be associated with the COPC.

Maximum HQs derived for diamondback terrapins feeding on fiddler crabs (90% of diet) and mummichogs (10%) at the site are 0.0052 for methylmercury, 0.056 for Aroclor 1268, and 0.46 for lead when TRVs employed in the evaluation are NOAEL TRVs. (PAHs were not assessed in terrapins or any other predator because PAHs seldom occurred in evaluated prey of the predators. Similarly, inorganic mercury was ultimately dismissed as a COPC in all predators because of extremely low mean NOAEL HQs [2 to 5 orders-of-magnitude less than 1] for this form of mercury.)

The above-discussed lines of evidence pertaining to the diamondback terrapin egg study and histopathology examination suggest that there is no potential risk to omnivorous reptiles utilizing the marsh and Purvis Creek system at the LCP Site. The line of evidence pertaining to HQ development provides an additional basis for this conclusion.

6.1.3 Omnivorous Birds (Assessment Endpoint 3)

In a study conducted in 1995, livers of seven clapper rails collected from the southern part of the site contained a mean mercury concentration of 3.84 mg/kg (wet wt) and a mean Aroclor 1268 concentration of 25.2 mg/kg (dry wt). No literature-based effect levels are available for Aroclor 1268 in livers of birds. However, mercury concentrations in bird livers have only been associated with avian mortality at levels of (all reported in terms of wet weight) 126.5 mg/kg (red-winged blackbirds), 54.5 mg/kg (grackles), and 4.6 to 91 mg/kg (white-tailed eagles).

In the same above-cited clapper rail study, histopathology examination did not indicate specific toxicity or specific uniform degeneration of tissues of clapper rails. In particular, myelin sheath and axonal degeneration, characteristic of mercury toxicity, were not observed except in one case, which may have been an artifact. Also, liver necrosis and fatty change, typical of PCB toxicity, were not noted.

Maximum HQs derived for red-winged blackbirds feeding on insects (90% of diet) and fiddler crabs (10%) at the site are 0.31 for methylmercury, 0.058 for Aroclor 1268, and 1.4 for lead when TRVs employed in the evaluation are NOAEL TRVs. The maximum HQ for blackbirds exposed to lead when the LOAEL TRV is utilized in the evaluation is 0.14.

Maximum HQs obtained for clapper rails feeding on fiddler crabs (85% of diet), insects (10%), and mummichogs (5%) at the site are 1.3 for methylmercury, 0.26 for Aroclor 1268, and 12 for lead when TRVs employed in the evaluation are NOAEL TRVs. Maximum HQs for clapper rails exposed to methylmercury and lead when LOAEL TRVs are employed in the evaluation are, respectively, 0.65 and 1.2. It is important to note that clapper rails at the Troup Creek reference location are characterized by a relatively high maximum NOAEL HQ for lead of 1.5.

The four above-discussed lines of evidence, considered collectively, indicate that the potential risk to omnivorous avian species utilizing the marsh and Purvis Creek is minimal except in the case of lead. There are no literature-based effects levels available for Aroclor 1268 in livers of birds, and the seemingly safe levels of mercury in bird livers pertain to just avian mortality. However, the histopathology examination of the same birds employed in the liver study documented the absence of numerous sublethal effects diagnostic of mercury and PCB poisoning in birds.

Maximum NOAEL HQs for red-winged blackbirds and clapper rails exposed to COPC approximate or are less than unity (1) except in the case of clapper rails exposed to lead. This unusual case (maximum NOAEL HQ = 12) occurred at a sampling station (Station "AB") where seepage containing high concentrations of total lead (mean concentration of 1,400 ug/L) was being discharged from the land. The main food item for clapper rails – fiddler crabs – at this station were characterized by body burdens of lead that averaged 22.14 mg/kg (dry wt).

6.1.4 Piscivorous Birds (Assessment Endpoint 4)

Results of the clapper rail study – the liver evaluation and histopathology examination, which were conducted in 1995 – are described above for Assessment Endpoint 3.

Maximum HQs obtained for green herons feeding on mummichogs (90% of diet), blue crabs (5%), and fiddler crabs (5%) at the site are 2.8 for methylmercury, 0.28 for Aroclor 1268, and

27 for lead when TRVs employed in the evaluation are NOAEL TRVs. Maximum HQs for green herons exposed to methylmercury and lead when LOAEL TRVs are employed in the evaluation are, respectively, 1.4 and 2.7. It is noteworthy that green herons at the Troup Creek reference location are characterized by a relatively high maximum NOAEL HQ for lead of 2.4.

The survey of abundance of wading birds, which was conducted in 1996, indicated that wading birds were present at significantly higher numbers at the LCP Site than at a reference site (Hawkins Creek). However, most wading birds were observed at the extreme northern boundary of the LCP Site (including tributaries of the Turtle River), far distant from the areas of greatest contamination by COPC.

The four above-discussed lines of evidence indicate that the potential risk to piscivorous avian species utilizing the marsh and Purvis Creek is minimal except in the case of lead. As discussed for omnivorous birds, literature-based effects levels are not available for Aroclor 1268 in livers of birds, and the seemingly safe levels of mercury in bird livers pertain to just avian mortality. Nevertheless, the histopathology examination of the same birds employed in the liver study documented the absence of numerous sublethal effects diagnostic of mercury and PCB poisoning in birds.

The maximum NOAEL HQ for green herons exposed to Aroclor 1268 is less than unity (1). The maximum NOAEL HQ for methylmercury – 2.8 – is partially discounted by the above-reviewed histopathology results and, also, results of the wading bird survey, which suggest that only limited members of populations of piscivorous birds are likely to be exposed to COPC. In the case of lead, to which results of the wading bird survey also apply, the maximum NOAEL HQ (27) occurred at a sampling station (Station 33, near the old oil-processing site) where concentration of total lead in surface water was a relatively high 7.0 ug/L The main food item for green herons – mummichogs – at this station was characterized by body burdens of lead that averaged 26.00 mg/kg (dry wt).

6.1.5 Herbivorous Mammals (Assessment Endpoint 5)

Maximum HQs obtained for marsh rabbits feeding on cordgrass (100% of diet) at the site are 0.054 for methylmercury, 1.2 for Aroclor 1268, and 28 for lead when TRVs employed in the evaluation are NOAEL TRVs. Maximum HQs for rabbits exposed to Aroclor 1268 and lead when LOAEL TRVs are employed in the evaluation are, respectively, 0.12 and 2.8. Rabbits at the Troup Creek and Crescent River reference locations are characterized by relatively high maximum NOAEL HQs for lead of, respectively, 7.8 and 13.

This single line of evidence (HQ development) suggests that the potential risk to herbivorous mammalian species utilizing the marsh and Purvis Creek is minimal except in the case of lead. Maximum NOAEL HQs for marsh rabbits exposed to COPC approximate or are less than unity (1) except in the case of rabbits exposed to lead. For lead, the maximum NOAEL HQ (28) occurred at a sampling station (Station 40, near the old oil-processing site) where concentration of lead in cordgrass (the food item for rabbits) was characterized by an unexpectedly high mean value of 7.60 mg/kg (dry wt). At the other eight sampling stations for which HQs were developed for rabbits exposed to lead, maximum NOAEL HQs approximate the values generated by the two reference locations.

6.1.6 Omnivorous Mammals (Assessment Endpoint 6)

Maximum HQs obtained for raccoons feeding on fiddler crabs (45% of diet), blue crabs (45%), and mummichogs (10%) at the site are 4.7 for methylmercury, 5.0 for Aroclor 1268, and 47 for lead when TRVs employed in the evaluation are NOAEL TRVs and an AUF of 1 is assumed. Comparable site HQs for an AUF of 0.3 are 1.4 for methylmercury, 1.5 for Aroclor 1268, and 14 for lead. Raccoons at the Troup Creek and Crescent River reference locations are characterized by relatively high maximum NOAEL HQs for lead of, respectively, 6.9 and 4.1.

Maximum site-related HQs for raccoons are 2.8 for methylmercury, 0.50 for Aroclor 1268, and 4.7 for lead when LOAEL TRVs are employed in the evaluation and an AUF of 1 is assumed. Comparable site HQs for an AUF of 0.3 are 0.81 for methylmercury, 0.15 for Aroclor 1268, and 1.4 for lead.

This single line of evidence (HQ development) suggests that there is a potential risk to omnivorous mammalian species in some areas of the marsh and Purvis Creek, particularly with the assumptions of NOAEL TRVs and an AUF of 1. The highest HQs for all COPC (i. e., methylmercury, Aroclor 1268, and lead) occurred at a sampling station (Station "AB") where seepage containing relatively high mean concentrations of methylmercury (23 ng/L), Aroclor 1268 (0.52 ug/L), and total lead (1,400 ug/L) was being discharged from the land. One of the main food items for raccoons – fiddler crabs – at this station was characterized by body burdens of methylmercury, Aroclor 1268, and lead that averaged, respectively, 0.611, 3.03, and 22.14 mg/kg (all in dry wt).

6.1.7 Piscivorous Mammals (Assessment Endpoint 7)

Maximum HQs obtained for river otters feeding on silver perch (50% of diet), mummichogs 30%), blue crabs (10%), and fiddler crabs (10%) at the site are 6.2 for methylmercury, 6.3 for Aroclor 1268, and 34 for lead when TRVs employed in the evaluation are NOAEL TRVs and an AUF of 1 is assumed. Comparable site HQs for an AUF of 0.66 are 4.1 for methylmercury, 4.3 for Aroclor 1268, and 23 for lead. River otters at the Troup Creek reference location are characterized by a relatively high maximum NOAEL HQ for lead of 5.3.

Maximum site-related HQs for river otters are 3.7 for methylmercury, 0.63 for Aroclor 1268, and 3.4 for lead when LOAEL TRVs are employed in the evaluation and an AUF of 1 is assumed. Comparable site HQs for an AUF of 0.66 are 2.4 for methylmercury, 0.43 for Aroclor 1268, and 2.3 for lead.

This single line of evidence (HQ development) suggests that there is a potential risk to piscivorous mammalian species – similar to the risk estimated for omnivorous mammals – in some areas of the marsh and Purvis Creek, particularly with the assumptions of NOAEL TRVs and an AUF of 1. For lead, the maximum NOAEL HQ (34) occurred at a sampling station

(Station 33, near the old oil-processing site) where concentration of total lead in surface water was a relatively high 7.0 ug/L One of the main food items for river otters – mummichogs – at this station was characterized by body burdens of lead that averaged 26.00 mg/kg (dry wt).

6.1.8 Finfishes (Assessment Endpoint 8)

Concentrations of total mercury in creek surface water at the LCP Site (8.0 - 420 ng/L, except 7,800 ng/L at the AB seep location) were greater than the applicable chronic ESV promulgated by Region 4 of the U. S. EPA (25 ng/L) at 11 of 28 (39%) sampling stations evaluated. Concentrations of Aroclor 1268 (<1.0 – 0.19 ug/L, except 0.52 at the AB seep location) clearly exceeded Region 4's chronic ESV for Aroclor 1254 (0.03 ug/L) at only 3 of 28 (11%) evaluated stations. Total lead concentrations (<5.0 – 7.0 ug/L, except 1,400 at the AB seep location) exceeded Region 4's chronic ESV (8.5 ug/L) only at the AB location. PAHs were detected at only 4 of 28 (14%) sampling stations evaluated. Total mercury concentrations monitored at a single sampling station (Station 5) in surface and subsurface waters over a 12-hour tidal cycle were often higher in subsurface water, and generally were positively correlated with concentrations of suspended particulate matter.

Seven silver perch (113 – 195 mm total length) collected in Purvis Creek had mean "whole body" burdens of methylmercury and Aroclor 1268 of, respectively, 0.68 and 0.91 mg/kg (wet wt). Methylmercury values for two black drum (*Pogonias cromis*; 215 – 230 mm total length) were 0.31 and 0.41 mg/kg; while Aroclor 1268 values were 0.78 and 1.4 mg/kg. A single spotted seatrout (*Cynoscion nebulosus*; 230 mm total length) was characterized by methylmercury and Aroclor 1268 body burdens of, respectively, 0.26 and 0.25 mg/kg. All of these body burdens of Aroclor 1268 are less than a NOAEL TRV of 1.6 mg/kg (wet wt). All methylmercury body burdens are greater than a NOAEL TRV of 0.15 mg/kg (wet wt), and all but the value for the spotted seatrout exceed a LOAEL TRV of 0.30 mg/kg (wet wt).

The above-presented empirical fish data generate NOAEL HQs for Aroclor 1268 that range from 0.16 to 0.88. For fish exposed to methylmercury, NOAEL HQs range from 1.7 to 4.5, while LOAEL HQs range from 0.87 to 2.3.

In the red drum model for Aroclor 1268, mean and maximum NOAEL HQs for fish feeding on mummichogs (40% of diet), fiddler crabs (30%), and blue crabs (30%) at the site are, respectively, 2.0 and 2.7. Mean and maximum LOAEL HQs for Aroclor 1268 are, respectively, 0.21 and 0.29. For methylmercury in the red drum model, mean and maximum NOAEL HQs are, respectively, 4.9 and 7.3. Mean and maximum LOAEL HQs for methylmercury are, respectively, 2.5 and 3.7.

Toxicity tests designed to evaluate chronic toxicity of "whole" water to mysids and sheepshead minnows generated similar results. Mean survival of mysids exposed in the laboratory to creek surface water collected from four sampling stations at the site and two reference locations (Troup Creek and the Crescent River) ranged from 92.4 to 100%, which is greater than the minimum acceptable survival for control organisms (80%). Mean growth (weight) of mysids exposed to site and reference waters was from 0.50 to 0.84 mg (dry wt), which is greater than weight of control organisms (0.48 mg).

Survival of sheepshead minnows exposed to creek surface water obtained from the same four sampling stations at the site and the two reference locations ranged from 80 to 100%, which is at least equal to the minimum acceptable survival for control organisms (80%). Mean growth (weight) of fish exposed to site water was statistically similar to weight observed for at least one reference location.

As described earlier for Assessment Endpoint 1, the benthic macroinvertebrate community evaluated in the Purvis Creek system appeared unremarkable in comparison to the communities at the reference locations with regard to the Shannon-Weaver diversity index (d) and the Lloyd-Ghelardi equitability index (e). The density of individual benthos at the four evaluated sampling stations in the creek system varied by an order-of-magnitude (from 435 to 4,500 individuals / m^2) and was sometimes less than the density observed at the reference locations (in both cases, 1,600 individuals / m^2). However, these data have limited utility for evaluating overall availability of food for finfishes in the Purvis Creek system.

The above-identified lines of evidence focus on two distinctly different types of ecological risks to finfishes utilizing the estuarine system: 1) risks to all fishes associated with direct exposure to water-borne COPC; and 2) risks to apex predators related to exposure to COPC through the food web. Regardless of the relationships between concentrations of COPC in surface water and ESVs, the more definitive measurement endpoint, which pertains to results of toxicity tests, indicates that there is no potential risk to finfishes via direct exposure of finfishes to COPC in surface water. Conversely, results of the empirical "body-burden" endpoint and the red drum model indicate that food-web-related accumulation of methylmercury, and possibly Aroclor 1268, constitutes a potential risk to indigenous finfishes in the Purvis Creek system.

6.2 Risk Description

The risk description consists of a "back-calculation" of HQs derived in food-web exposure models for selected predators and major COPC. In this theoretical exercise (Table 18), HQs originally derived during risk estimation were back-calculated to unity (1), thereby identifying ecologically acceptable "body burdens" of COPC in prey of predators. These ecologically acceptable body burdens of COPC in prey were then related to associated concentrations of COPC in marsh surface sediment to estimate ecologically safe concentrations (ESCs) of COPC in the sediment.

PAHs were eliminated from this exercise because they were seldom detected in prey of predators. Similarly, inorganic mercury was not evaluated because this form of mercury was never associated with predator HQs > 1. In addition, the exercise was performed for only those predators: 1) whose diet consisted of a substantial percentage of prey with high fidelity to surface sediment; 2) for which a reasonable regressional relationship (or gradient) could be established between concentration of COPC in the dominant prey of predator and sediment; and 3) for which mitigating and/or confounding factors were absent.

The prey species evaluated in this investigation (excluding insects, which were collected at only one sampling station) were cordgrass, fiddler crabs, mummichogs, blue crabs, and silver perch. These prey species were selected for evaluation (Honeywell International, 2000c) because they tended to integrate environmental contamination over progressively greater geographical areas. Of these five prey species, only cordgrass and fiddler crabs can be considered to have high fidelity to their environment and, consequently, reflect a known (and measured) concentration of COPC in surface sediment. Of the three remaining prey species, only mummichogs might be argued as being environmentally faithful. However, these fish have been documented (Lotrich, 1975) to move as much as 375 m during the summer, thereby precluding a reliable estimate of environmental exposure to COPC in sediment.

Cordgrass or fiddler crabs constituted a substantial percentage of the diet of diamondback terrapin (90% fiddler crabs), clapper rails (85% fiddler crabs), marsh rabbits (100% cordgrass) and raccoons (45% fiddler crabs). Consequently, these are the four predators for which ESCs of COPC in sediment are addressed in the following section of this report.

6.2.1 Diamondback Terrapin

The second of the above-identified criteria for estimating ESCs of COPC in sediment – i. e., documentation of a reasonable regressional relationship between concentration of COPC in the dominant prey of predator and sediment – was established for diamondback terrapin exposed to methylmercury (Figure 13) and Aroclor 1268 (Figure 15). (The relationship for total mercury is presented in Table 14 only for general interest.) A reliable regressional relationship could not be documented for lead because of numerous undetected and blank-contaminated values of lead in the dominant prey of terrapins (fiddler crabs; Table 6). In addition, the one set of fiddler-crab samples not compromised by poor data quality was characterized by extraordinarily high concentrations of lead in surface water (7,800 ng/L; Table 3), as well as in surface sediment (120 mg/kg, dry wt; Table 5).

In the case of diamondback terrapins exposed to methylmercury, the "best" estimate of a LOAEL-related ESC in surface sediment is believed to be 0.37 mg/kg (dry wt), while a NOAEL-related ESC is estimated as 0.10 mg/kg (Table 18). Note that these estimates are the geometric means of values generated by linear (r^2 = 0.53) and exponential (r^2 =0.82) regressional relationships (Figure 13). The polynomial relationship was not employed in this evaluation or in the evaluations for clapper rails and raccoons because a logical theoretical basis for that relationship was not apparent.

For diamondback terrapins exposed to Aroclor 1268, the "best" estimate of a LOAEL-related ESC in surface sediment is believed to be 22 mg/kg (dry wt), while a NOAEL-related ESC is estimated as 5.9 mg/kg (Table 18). These estimates of ESCs of Aroclor 1268 in surface sediment are based on a r^2 of 0.94 for the linear regressional relationship and a r^2 of 0.97 for the exponential relationship (Figure 15).

Table 6.__Major chemicals of potential concern (COPC) and lipid content in whole bodies of biota of estuary at LCP Site[a]

Biota and sampling station	Replicate 1	2	3	4	5	6	7	8	Mean (x)[b]	95% confidence interval[c]
					Total Mercury (mg/kg or ppm,dry wt)[d]					
Cordgrass (all marsh stations)										
Southern Part of Site										
Main Canal –upstream (25)	0.29	0.099	0.086	–	–	–	–	–	0.158	0 - 0.441
Main Canal – downstream (26)	0.038	0.030	0.024	–	–	–	–	–	0.031	0.014 - 0.048
Streamlet to Main Canal (19)	0.023	0.052	0.038	–	–	–	–	–	0.038	0.003 - 0.073
Eastern Creek (22)	0.21	0.080	0.073	–	–	–	–	–	0.121	0 - 0.312
Western Creek Complex (27)	0.019	0.015	0.019	–	–	–	–	–	0.018	0.012 - 0.024
Mouth of Purvis Creek (28)	0.017	0.028	0.022	–	–	–	–	–	0.022	0.008 - 0.036
Northern Part of Site										
Near old oil-processing site (40)	0.067	0.025	0.040	–	–	–	–	–	0.044	0 - 0.096
Northern Creek (42)	0.038	0.018	0.040	–	–	–	–	–	0.032	0.002 - 0.062
Western Part of Site										
Mouth of central creek (46)	0.024	0.033	0.028	–	–	–	–	–	0.028	0.017 - 0.039
Reference Locations										
Troup Creek	0.0048	0.0020	0.0063	–	–	–	–	–	0.0044	0 - 0.0099
Crescent River	0.0011U	0.0069	0.0040	–	–	–	–	–	0.0038	0.0041 - 0.012
Fiddler Crabs (all marsh stations)										
Southern Part of Site										
By "AB" seepage from land	0.78	0.71	0.83	0.92	1.8	1.6	0.86	–	1.07	0.66 - 1.48
Main Canal –upstream (25)[f]	0.95	0.63	0.74	0.66	–	–	–	–	0.74	0.52 - 0.96
Mouth of Purvis Creek (28)	0.16	0.16	0.15	0.18	0.13	0.15	0.21	–	0.16	0.14 - 0.18
Reference Locations										
Troup Creek	0.036	0.038	0.029	0.039	0.028	0.022	0.022	–	0.031	0.024 - 0.038
Crescent River	0.018	0.020	0.023	0.017	0.015	0.015	0.019	–	0.018	0.015 - 0.021
Insects (marsh station)										
Southern Part of Site										
Main Canal – downstream (26)	0.032	–	–	–	–	–	–	–	0.032	–
Mummichogs (all creek stations)										
Southern Part of Site										
Eastern Creek – upstream (6)	0.43	0.49	0.38	–	–	–	–	–	0.433	0.295 - 0.571
Eastern Creek – downstream (9)	0.78	0.71	0.84	–	–	–	–	–	0.777	0.615 -0.939
Western Creek Complex (13)	0.27	0.37	0.34	–	–	–	–	–	0.327	0.200 - 0.454
Northern Part of Site										
Near old oil-processing site (33)	0.33	0.36	0.42	–	–	–	–	–	0.370	0.256 - 0.484
Reference Locations										
Troup Creek	0.034	0.044	0.045	–	–	–	–	–	0.041	0.026 - 0.056
Crescent River	0.035	0.023	0.016	–	–	–	–	–	0.025	0.001 - 0.049
Blue Crabs										
Site										
Upper Purvis Creek	1.2	2.5	1.5	1.5	1.9	2.2	1.2	–	1.714	1.251 - 2.177
Lower Purvis Creek	1.8	2.2	2.2	1.3	1.6	0.96	2.0	–	1.723	1.290 - 2.156
Reference Locations										
Troup Creek	0.18	0.027	0.073	0.076	0.044	0.054	0.028	–	0.069	0.020 - 0.118
Crescent River	0.098	0.054	0.075	0.053	0.071	0.16	0.036	–	0.078	0.040 - 0.116
Silver Perch										
Site										
Purvis Creek	–	2.4	3.2	3.2	0.54	2.9	2.4	0.18	2.12	0.97 - 3.27
Reference Locations										
Troup Creek	0.11	0.13	0.15	0.20	0.18	0.15	0.15	0.14	0.151	0.128 - 0.174
Crescent River	–	–	–	–	–	–	–	–	–	–

Table 6.__Continued

Biota and sampling station	Replicate 1	2	3	4	5	6	7	8	Mean (x)[b]	95% confidence interval[c]
	Methylmercury (mg/kg or ppm,dry wt) – [% of total Mercury][d]									
Cordgrass (all marsh stations)										
Southern Part of Site										
Main Canal –upstream (25)	0.0054 [2]	0.0059 [6]	0.0066 [8]	–	–	–	–	–	0.0060 [5]	0.0045 - 0.0075
Main Canal – downstream (26)	0.00093 [2]	0.0011 [4]	0.00067 [3]	–	–	–	–	–	0.00090 [3]	0.00035 - 0.00145
Streamlet to Main Canal (19)	0.00071 [3]	0.0016 [3]	0.0014 [4]	–	–	–	–	–	0.00124 [3]	0.00007 - 0.00241
Eastern Creek (22)	0.0092 [4]	0.0095 [12]	0.0033 [5]	–	–	–	–	–	0.00733 [7]	0 - 0.01603
Western Creek Complex (27)	0.00060 [4]	0.00043 [3]	0.00052 [3]	–	–	–	–	–	0.00058 [3]	0.00011 - 0.00105
Mouth of Purvis Creek (28)	0.00090 [5]	0.0012 [4]	0.00048 [2]	–	–	–	–	–	0.00086 [4]	0 - 0.00175
Northern Part of Site										
Near old oil-processing site (40)	0.0029 [4]	0.0025 [10]	0.0029 [7]	–	–	–	–	–	0.00277 [7]	0.00220 - 0.00334
Northern Creek (42)	0.0016 [4]	0.0014 [8]	0.0014 [4]	–	–	–	–	–	0.00147 [5]	0.00117 - 0.00177
Western Part of Site										
Mouth of central creek (46)	0.00082 [4]	0.0014 [4]	0.00091 [3]	–	–	–	–	–	0.00108 [4]	0.00038 - 0.00178
Reference Locations										
Troup Creek	0.00054 [11]	0.00033 [16]	0.00021 [3]	–	–	–	–	–	0.00036 [10]	0 - 0.00078
Crescent River	0.00030 [–]	0.00042 [6]	0.00028 [7]	–	–	–	–	–	0.00033 [6]	0.00014 - 0.00052
Fiddler Crabs (all marsh stations)										
Southern Part of Site										
By "AB" seepage from land	0.55 [71]	0.52 [73]	0.65 [78]	0.62 [67]	0.64 [36]	0.65 [41]	0.65 [76]	–	0.611 [63]	0.561 - 0.661
Main Canal –upstream (25)[f]	0.32 [34]	0.37 [59]	0.35 [47]	0.36 [55]	–	–	–	–	0.350 [49]	0.318 - 0.382
Mouth of Purvis Creek (28)	0.11 [69]	0.12 [75]	0.13 [87]	0.12 [67]	0.084 [65]	0.12 [80]	0.14 [67]	–	0.118 [73]	0.101 - 0.135
Reference Locations										
Troup Creek	0.036 [100]	0.031 [82]	0.026 [90]	0.023 [59]	0.026 [93]	0.024 [109]	0.028 [127]	–	0.028 [94]	0.024 - 0.032
Crescent River	0.014 [78]	0.0072 [36]	0.021 [91]	0.015 [88]	0.0071 [47]	0.011 [73]	0.013 [68]	–	0.013 [89]	0.009 - 0.017
Insects (marsh station)										
Southern Part of Site										
Main Canal – downstream (26)	0.018 [56]	–	–	–	–	–	–	–	0.018 [56]	–
Mummichogs (all creek stations)										
Southern Part of Site										
Eastern Creek – upstream (6)	0.43 [100]	0.40 [82]	0.41 [108]	–	–	–	–	–	0.413 [97]	0.376 -0.450
Eastern Creek – downstream (9)	0.87 [112]	0.74 [104]	0.76 [90]	–	–	–	–	–	0.790 [102]	0.620 - 0.960
Western Creek Complex (13)	0.32 [119]	0.39 [105]	0.38 [112]	–	–	–	–	–	0.363 [112]	0.269 - 0.457
Northern Part of Site										
Near old oil-processing site (33)	0.36 [109]	0.40 [111]	0.46 [110]	–	–	–	–	–	0.407 [110]	0.287 - 0.527
Reference Locations										
Troup Creek	0.034 [100]	0.038 [86]	0.049 [109]	–	–	–	–	–	0.040 [98]	0.021 - 0.059
Crescent River	0.048 [137]	0.016 [70]	0.016 [100]	–	–	–	–	–	0.027 [102]	0 - 0.073
Blue Crabs										
Site										
Upper Purvis Creek	1.4 [117]	2.4 [96]	1.5 [100]	1.8 [120]	2.5 [132]	2.7 [123]	1.2 [100]	–	1.93 [113]	1.38 - 2.48
Lower Purvis Creek	1.4 [78]	2.0 [91]	3.0 [150]	1.5 [115]	1.6 [100]	0.73 [76]	1.7 [85]	–	1.70 [99]	1.06 - 2.34
Reference Locations										
Troup Creek	0.16 [89]	0.029 [107]	0.078 [107]	0.070 [92]	0.061 [139]	0.080 [148]	0.032 [114]	–	0.073 [114]	0.032 - 0.114
Crescent River	0.11 [112]	0.044 [81]	0.073 [97]	0.061 [115]	0.056 [79]	0.22 [138]	0.032 [89]	–	0.085 [102]	0.026 - 0.144
Silver Perch										
Site										
Purvis Creek	2.7 [–]	2.4 [100]	2.5 [78]	3.5 [109]	0.75 [139]	2.9 [100]	2.7 [112]	0.20 [111]	2.21 [107]	1.27 - 3.15
Reference Locations										
Troup Creek	0.13 [118]	0.19 [146]	0.12 [80]	0.28 [140]	0.20 [111]	0.16 [107]	0.13 [87]	0.18 [129]	0.17 [115]	0.13 - 0.21
Crescent River	–	–	–	–	–	–	–	–	–	–

Table 6.__Continued

Biota and sampling station	Replicate 1	2	3	4	5	6	7	8	Mean (x)[b]	95% confidence interval[c]
Inorganic Mercury (mg/kg or ppm,dry wt)[a]										
Cordgrass (all marsh stations)										
Southern Part of Site										
Main Canal –upstream (25)	0.28	0.093	0.079	–	–	–	–	–	0.151	0 - 0.429
Main Canal – downstream (26)	0.037	0.029	0.023	–	–	–	–	–	0.030	0 - 0.082
Streamlet to Main Canal (19)	0.022	0.050	0.037	–	–	–	–	–	0.036	0.001 - 0.071
Eastern Creek (22)	0.20	0.070	0.070	–	–	–	–	–	0.113	0 - 0.299
Western Creek Complex (27)	0.018	0.015	0.018	–	–	–	–	–	0.017	0.013 - 0.021
Mouth of Purvis Creek (28)	0.016	0.027	0.022	–	–	–	–	–	0.022	0.008 - 0.036
Northern Part of Site										
Near old oil-processing site (40)	0.064	0.022	0.037	–	–	–	–	–	0.041	0 - 0.093
Northern Creek (42)	0.036	0.017	0.039	–	–	–	–	–	0.031	0.001 - 0.061
Western Part of Site										
Mouth of central creek (46)	0.023	0.032	0.027	–	–	–	–	–	0.027	0.016 - 0.038
Reference Locations										
Troup Creek	0.0043	0.0017	0.0061	–	–	–	–	–	0.0040	0 - 0.0139
Crescent River	–	0.0065	0.0037	–	–	–	–	–	0.0051	0.0001 - 0.0101
Fiddler Crabs (all marsh stations)										
Southern Part of Site										
By "AB" seepage from land	0.23	0.19	0.18	0.30	1.2	0.95	0.21	–	0.466	0.074 - 0.858
Main Canal –upstream (25)[f]	0.63	0.26	0.39	0.30	–	–	–	–	0.395	0.038 - 0.752
Mouth of Purvis Creek (28)	0.050	0.040	0.020	0.060	0.046	0.030	0.070	–	0.045	0.017 - 0.073
Reference Locations										
Troup Creek	0	0.0070	0.0030	0.016	0.0020	0	0	–	0.0040	0 - 0.0095
Crescent River	0.0040	0.013	0.0020	0.0020	0.0079	0.0040	0.0060	–	0.0056	0.0020 - 0.0092
Insects (marsh station)										
Southern Part of Site										
Main Canal – downstream (26)	0.014	–	–	–	–	–	–	–	0.014	–

Table 6.__Continued

Biota and sampling station	Replicate 1	2	3	4	5	6	7	8	Mean $(x)^b$	95% confidence interval[c]
				Aroclor 1268 (mg/kg or ppm,dry wt)						
Cordgrass (all marsh stations)										
Southern Part of Site										
Main Canal – upstream (25)	0.20J	0.082J	0.068J	–	–	–	–	–	0.117	0 - 0.296
Main Canal – downstream (26)	0.36J	0.18J	0.086J	–	–	–	–	–	0.209	0 - 0.554
Streamlet to Main Canal (19)	0.37U	0.38U	0.054J	–	–	–	–	–	0.143	–
Eastern Creek (22)	0.25J	0.14J	0.28J	–	–	–	–	–	0.223	0.039 - 0.407
Western Creek Complex (27)	0.35U	0.32U	0.33U	–	–	–	–	–	0.167	–
Mouth of Purvis Creek (28)	0.33U	0.37U	0.31U	–	–	–	–	–	0.168	–
Northern Part of Site										
Near old oil-processing site (40)	0.11J	0.32U	0.057J	–	–	–	–	–	0.109	–
Northern Creek (42)	0.069J	0.43U	0.088J	–	–	–	–	–	0.124	–
Western Part of Site										
Mouth of central creek (46)	0.048J	0.33U	0.37U	–	–	–	–	–	0.133	–
Reference Locations										
Troup Creek	0.37U	0.45U	0.32U	–	–	–	–	–	0.190	–
Crescent River	0.40U	0.45U	0.45U	–	–	–	–	–	0.217	–
Fiddler Crabs (all marsh stations)										
Southern Part of Site										
By "AB" seepage from land	1.7	3.3	2.9	2.2	2.6	2.5	6.0	–	3.03	1.74 - 4.32
Main Canal – upstream (25)[f]	2.1	2.2	1.8	2.0	–	–	–	–	2.02	1.75 - 2.29
Mouth of Purvis Creek (28)	0.37	0.66	0.43	0.67	0.68	0.65	0.41	–	0.55	0.42 - 0.68
Reference Locations										
Troup Creek	0.34U	0.31U	0.31U	0.33U	0.28U	0.31U	0.28U	–	0.154	–
Crescent River	0.32U	0.35U	0.38U	0.34U	0.35U	0.32U	0.38U	–	0.174	–
Insects (marsh station)										
Southern Part of Site										
Main Canal – downstream (26)	0.079J	–	–	–	–	–	–	–	0.079	–
Mummichogs (all creek stations)										
Southern Part of Site										
Eastern Creek – upstream (6)	1.4	3.0	1.5	–	–	–	–	–	1.97	0 - 4.21
Eastern Creek – downstream (9)	2.6	0.95	1.2	–	–	–	–	–	1.58	0 - 3.79
Western Creek Complex (13)	0.37J	1.1	0.98	–	–	–	–	–	0.82	0 - 1.79
Northern Part of Site										
Near old oil-processing site (33)	1.1	0.70	0.58	–	–	–	–	–	0.79	0.12 - 1.46
Reference Locations										
Troup Creek	0.41U	0.45U	0.45U	–	–	–	–	–	0.22	–
Crescent River	0.43U	0.33U	0.41U	–	–	–	–	–	0.20	–
Blue Crabs										
Site										
Upper Purvis Creek	0.81	0.48	0.90	0.84	1.3	0.54	0.50	–	0.77	0.50 - 1.04
Lower Purvis Creek	0.25J	0.32J	0.56	0.76	1.2	0.98	0.80	–	0.70	0.39 - 1.01
Reference Locations										
Troup Creek	0.33U	0.28U	0.28U	0.24U	0.33U	0.29U	0.40U	–	0.15	–
Crescent River	0.29U	0.55U	0.26U	0.41U	0.38U	0.66U	0.41U	–	0.21	–
Silver Perch										
Site										
Purvis Creek	3.6	3.2	0.70	5.3	0.35	6.3	3.7	0.092J	2.91	0.97 - 4.85
Reference Locations										
Troup Creek	0.41U	0.066J	0.90U	0.52U	0.38U	1.3U	0.76U	0.86U	0.33	–
Crescent River	–	–	–	–	–	–	–	–	–	–

Table 6.__Continued

Biota and sampling station	Replicate 1	2	3	4	5	6	7	8	Mean (x)[b]	95% confidence interval[c]
				Lead (mg/kg or ppm,dry wt)						
Cordgrass (all marsh stations)										
Southern Part of Site										
Main Canal –upstream (25)	4.3	3.3	3.1	–	–	–	–	–	3.57	1.98 - 5.16
Main Canal – downstream (26)	2.9	4.8	2.2	–	–	–	–	–	3.30	0 - 6.65
Streamlet to Main Canal (19)	2.7	2.9	2.4	–	–	–	–	–	2.67	2.05 - 3.29
Eastern Creek (22)	3.8	3.2	3.3	–	–	–	–	–	3.43	2.63 - 4.23
Western Creek Complex (27)	2.2	1.6	3.0	–	–	–	–	–	2.27	0.53 - 4.01
Mouth of Purvis Creek (28)	2.8	3.1	1.8	–	–	–	–	–	2.57	0.88 - 4.26
Northern Part of Site										
Near old oil-processing site (40)	10	4.2	8.6	–	–	–	–	–	7.60	0.07 - 15.13
Northern Creek (42)	5.5	3.1	2.8	–	–	–	–	–	3.80	0.12 - 7.48
Western Part of Site										
Mouth of central creek (46)	2.7	3.1	3.6	–	–	–	–	–	3.13	2.01 - 4.25
Reference Locations										
Troup Creek	1.6B	2.1	2.3	–	–	–	–	–	2.00	1.11 - 2.89
Crescent River	2.2	3.4	4.5	–	–	–	–	–	3.37	0.51 - 6.23
Fiddler Crabs (all marsh stations)										
Southern Part of Site										
By "AB" seepage from land	21	14	24	28	35	18	15	–	22.14	15.18 - 29.10
Main Canal –upstream (25)[f]	0.72B	2.4	2.1	2.4	–	–	–	–	1.90	0.63 - 3.17
Mouth of Purvis Creek (28)	1.4B	1.2B	1.2B	1.6U	0.90B	1.0B	0.86B	–	1.05	–
Reference Locations										
Troup Creek	1.1B	0.92B	0.92B	1.6B	1.4U	1.6U	1.4U	–	0.96	–
Crescent River	1.3B	1.8	2.0	1.3B	0.81B	0.72B	1.3B	–	1.32	0.89 - 1.75
Insects (marsh station)										
Southern Part of Site										
Main Canal – downstream (26)	1.1B	–	–	–	–	–	–	–	1.10	–
Mummichogs (all creek stations)										
Southern Part of Site										
Eastern Creek – upstream (8)	2.0U	2.1U	1.4B	–	–	–	–	–	1.15	–
Eastern Creek – downstream (9)	2.2U	0.85B	1.0B	–	–	–	–	–	0.98	–
Western Creek Complex (13)	2.1U	2.0U	2.4	–	–	–	–	–	1.48	–
Northern Part of Site										
Near old oil-processing site (33)	70	6.50	1.5B	–	–	–	–	–	26.00	0 - 120.88
Reference Locations										
Troup Creek	5.9	2.3U	1.3B	–	–	–	–	–	2.78	–
Crescent River	1.8U	1.7U	1.7U	–	–	–	–	–	0.87	–
Blue Crabs										
Site										
Upper Purvis Creek	1.5U	0.65B	1.5U	1.3U	1.5U	1.4U	1.5U	–	0.71	–
Lower Purvis Creek	0.91B	1.6U	1.6U	1.1B	2.6	1.7U	1.3U	–	1.10	–
Reference Locations										
Troup Creek	1.5U	1.4U	1.3U	1.1U	1.7U	1.5U	2.0U	–	0.75	–
Crescent River	1.3U	2.5U	1.2U	1.9U	1.9U	2.2B	2.1U	–	1.09	–
Silver Perch										
Site										
Purvis Creek	1.5U	1.4U	1.7U	1.6U	1.5U	1.6U	1.6U	1.5U	0.78	–
Reference Locations										
Troup Creek	2.1U	1.7U	2.3U	2.4U	1.9U	3.3U	1.7U	2.2U	1.10	–
Crescent River	–	–	–	–	–	–	–	–	–	–

Table 6.__Continued

Biota and sampling station	Replicate 1	2	3	4	5	6	7	8	Mean (x)[b]	95% confidence interval[c]
				Lipid Content(%, wet wt)						
Fiddler Crabs (all marsh stations)										
Southern Part of Site										
By "AB" seepage from land	3.0	5.1	3.8	4.3	4.2	4.2	1.6	–	3.74	2.69 - 4.79
Main Canal --upstream (25)[f]	0.61	1.4	1.2	2.4	–	–	–	–	1.40	0.22 - 2.58
Mouth of Purvis Creek (28)	0.53	0.96	0.72	0.67	0.73	1.2	0.54	–	0.76	0.54 - 0.98
Reference Locations										
Troup Creek	3.4	4.5	1.8	1.9	2.3	3.2	1.4	–	2.64	1.62 - 3.66
Crescent River	2.2	0.74	1.0	0.72	2.5	1.2	2.2	–	1.51	0.80 - 2.22
Mummichogs (all creek stations)										
Southern Part of Site										
Eastern Creek -- upstream (6)	0.97	0.91	0.77	–	–	–	–	–	0.88	0.58 - 1.18
Eastern Creek -- downstream (9)	0.69	0.56	0.56	–	–	–	–	–	0.60	0.40 - 0.80
Western Creek Complex (13)	1.6	1.8	3.1	–	–	–	–	–	2.17	0.16 - 4.18
Northern Part of Site										
Near old oil-processing site (33)	3.4	4.5	3.8	–	–	–	–	–	3.90	2.51 - 5.29
Reference Locations										
Troup Creek	1.3	2.1	1.1	–	–	–	–	–	1.50	0.18 - 2.82
Crescent River	1.3	0.85	1.3	–	–	–	–	–	1.15	0.50 - 1.80
Blue Crabs										
Site										
Upper Purvis Creek	0.65	0.73	0.81	1.0	2.4	1.1	0.74	–	1.06	0.50 - 1.62
Lower Purvis Creek	0.52	1.1	1.4	0.95	2.6	1.4	1.4	–	1.34	0.75 - 1.93
Reference Locations										
Troup Creek	1.8	4.3	5.8	7.4	2.0	4.3	7.3	–	4.70	2.59 - 6.81
Crescent River	1.7	1.4	4.3	1.1	5.3	2.6	0.84	–	2.46	0.88 - 4.04
Silver Perch										
Site										
Purvis Creek	6.3	5.7	0.45	5.4	6.1	5.1	7.0	4.0	5.01	3.30 - 6.72
Reference Locations										
Troup Creek	1.2	1.6	2.4	1.4	1.8	1.4	1.1	0.66	1.44	0.98 - 1.90
Crescent River	–	–	–	–	–	–	–	–	–	–

[a]Biota were collected during the period of October 10 - 19, 2000, by hand (cordgrass and fiddler crabs), nets (insects), baited traps (mummichogs and blue crabs), and hook-and-line (silver perch). General coding in table is as follows: U (undetected), J (present at > minimum detection limit but < reporting limit), and B (present in blank as well as sample).

[b]**Bold print** identifies mean body burdens at site sampling stations that are elevated in comparison to mean body burdens at reference locations. Mean values include undetected chemical values (U) calculated as 1/2 of their detection limits.

[c]**Bold print** identifies body burdens at site sampling stations that appear to be statistically elevated in comparison to body burdens at reference locations (i. e., lower limit of 95% confidence interval at site station > upper limit of 95% confidence at either of the two reference locations). Confidence intervals are not determined for sets of chemical data that include undetected values (U).

[d]Total mercury and methylmercury concentrations were reported by the laboratory in terms of wet weight (Appendix C. 2.2 of Volume II of this report). Those values were converted to a dry-weight basis by normalizing the values according to percent solids content (Appendix C.1.2 of Volume II of this report).

[e]Inorganic mercury concentrations are calculated as the difference between the total mercury and methylmercury concentrations presented in this table. No inorganic mercury values are presented for blue crabs, mummichogs, or silver perch because all mercury in these biota was in the form of methylmercury.

[f]Crabs collected for Replicate 2 at Station 25 were mud crabs.

Table 7.__Statistical analysis of survival and growth of mysids (*Mysidopsis bahia*) exposed for 7 days to creek surface water of estuary at LCP Site[a]

	1. Number of surviving mysids (mean weight; mg, dry wt)[b]									
	Replicate – r								Mean	Variance
Water source (S)	1	2	3	4	5	6	7	8	($\bar{x}$)	(s^2)
Control	5 (0.39)	5 (0.32)	5 (0.57)	4 (0.45)	5 (0.41)	5 (0.33)	5 (0.52)	5 (0.85)	4.88 (0.48)	0.12 (0.029)
Southern Part of Site										
Main Canal (5)	5 (0.47)	4 (0.90)	5 (0.66)	5 (0.85)	5 (0.47)	4 (1.02)	5 (0.51)	4 (0.73)	4.62 (0.70)	0.27 (0.044)
Eastern Creek (7)	4 (0.58)	5 (0.59)	5 (1.11)	5 (0.75)	5 (0.53)	5 (1.29)	5 (1.06)	5 (0.78)	4.88 (0.84)	0.12 (0.078)
Mouth of Purvis Creek (16)	5 (0.65)	4 (1.90)	5 (0.70)	4 (0.49)	5 (1.36)	5 (0.45)	5 (0.35)	5 (0.45)	4.75 (0.79)	0.21 (0.303)
Northern Part of Site										
Near old oil-processing site (33)	5 (0.57)	5 (0.76)	5 (0.75)	5 (0.42)	5 (0.33)	5 (0.44)	5 (0.40)	5 (0.36)	5.00 (0.50)	0 (0.029)
Reference (R) Locations										
Troup Creek	5 (0.53)	5 (0.41)	5 (0.61)	5 (0.76)	5 (0.49)	5 (0.71)	5 (0.50)	5 (0.43)	5.00 (0.56)	0 (0.017)
Crescent River	5 (0.46)	5 (0.54)	5 (0.69)	5 (0.79)	5 (0.52)	5 (0.84)	5 (0.54)	5 (0.46)	5.00 (0.60)	0 (0.023)

No further statistical analysis required

1. Mean survival of mysids exposed to all water sources was from 92.4 to 100%, which was greater than minimum acceptable survival for control organisms (80%).
2. Mean growth (weight) of mysids exposed to water from the site and reference locations was from 0.50 to 0.84 mg, which was greater than weight of control organisms (0.48 mg).

[a]Creek surface water employed in mysid toxicity test was collected directly into sampling containers on October 11 (Days 1 and 2 of test), October 13 (Days 3, 4, and 5 of test), and October 16 (Days 6 and 7 of test), 2000. Laboratory control water consisted of deionized water to which commercial sea salts were added.

[b]Each replicate (r) consisted of 5 mysids at start of test (i. e., 5 mysids at end of test = 100% survival).

Table 8.__Statistical analysis of survival and growth of sheepshead minnows (*Cyprinodon variegatus*) exposed for 7 days to creek surface water of estuary at LCP Site[a]

1. Number of surviving fish (mean weight; mg, dry wt)[b]

Water source (S)	Replicate – r: 1	2	3	4	Mean ($\bar{x}$)	Variance (s^2)
Control	10 (1.22)	10 (1.01)	10 (1.14)	10 (1.16)	10.00 (1.13)	0 (0.008)
Southern Part of Site						
Main Canal (5)	10 (1.51)	10 (1.24)	10 (0.99)	10 (1.33)	10.00 (1.27)	0 (0.047)
Eastern Creek (7)	10 (1.59)	9 (0.90)	8 (0.76)	9 (1.10)	9.00 (1.09)	0.67 (0.132)
Mouth of Purvis Creek (16)	10 (1.00)	10 (1.00)	9 (0.95)	8 (0.68)	9.25 (0.91)	0.92 (0.024)
Northern Part of Site						
Near old oil-processing site (33)	9 (0.40)	7 (0.50)	10 (0.68)	6 (0.48)	8.00 (0.52)	3.35 (0.014)
Reference (R) Locations						
Troup Creek	8 (0.78)	9 (1.36)	9 (0.54)	8 (0.50)	8.50 (0.79)	0.34 (0.158)
Crescent River	10 (1.17)	10 (1.57)	10 (1.22)	9 (1.01)	9.75 (1.24)	0.25 (0.056)

2. Cochran's (C) test for homogeneity of variances of fish weight[c]
(No further statistical analysis required for fish survival since mean survival of fish exposed to all water sources was from 80 to 100%, which was at least equal to minimum acceptable survival for control organisms (80%))

$C_{(cal.)} = s^2(\text{max.}) / s^2(\text{total})$

$C_{(cal.)} = 0.158 / 0.439 = 0.36$ ns,
as compared to $C_{(tab.)} = 0.48$
for $k = 7$ and $v = 3$

3. Parametric one-way analysis of variance (ANOVA) followed by Tukey's (w) test of fish weight[d]

Source of variation in weight	Degrees of freedom (df)	Sum of squares (SS)	Mean square (MS)	$F_{(cal.)}$
Water source (S)	s - 1 = 6	1.77	0.30	5.00 **,
Error (R)	s (r - 1) = 21	1.31	0.06	
Total (T)	sr - 1 = 27	3.08		

as compared to
$F_{(tab.)} = 3.81$ for $P = 0.01$,
6 numerator df, and 21 denominator df

Water source (S):	Station 33	Troup Creek	Station 16	Station 7	Control	Crescent River	Station 5
Mean ($\bar{x}$) weight (mg, dry wt):	0.52	0.79	0.91	1.09	1.13	1.24	1.27

$w_{(P = 0.05)}$ = q (square root of error MS / r)
= 4.60 (square root of 0.06 / 4)
= 0.55

[a]Creek surface water employed in fish toxicity test was collected directly into sampling containers on October 11 (Days 1 and 2 of test), October 13 (Days 3, 4, and 5 of test), and October 16 (Days 6 and 7 of test), 2000. Laboratory control water consisted of deionized water to which commercial sea salts were added.

[b]Each replicate (r) consisted of 10 fish at start of test (i. e., 10 fish at end of test = 100% survival).

[c]Cochran's (C) test, when applied to fish weight data indicated homogeneity of variances (as indicated by the symbol "ns"). Consequently, further statistical analyses were conducted with original (untransformed) data by parametric protocols.

Table 8.__Continued

[d]A parametric ANOVA applied to fish weight data documented the presence of statistically significant differences in weight (as indicated by the symbol "***" for $F_{[cal.]}$). Tukey's (w) test indicates that a major source of these differences is the relatively low weight of fish exposed to water from Station 33, although weight for that station is statistically similar to weight for Troup Creek (a reference location) and Station 16. In Tukey's test, weight data underscored by the same horizontal line are not significantly different (i. e., $x_1 - x_2 < w$ value of 0.55), whereas data not underscored by the same horizontal line are significantly different ($x_1 - x_2 > w$ value of 0.55).

Table 9.__Statistical analysis of survival and growth of amphipods (*Leptocheirus plumulosus*) exposed for 28 days to creek surface sediment in marsh grid of estuary at LCP Site[a]

1. Number of surviving amphipods (mean weight; mg, dry wt)[b]

Sediment source (S)	Replicate -- r: 1	2	3	4	5	Mean ($\bar{x}$)	Variance (s^2)
Control	15 (0.62)	12 (0.41)	12 (0.69)	14 (0.64)	18 (0.36)	14.20 (0.54)	6.2 (0.022)
Marsh Grid (from north to south)							
B7	6 (1.25)	3 (1.26)	14 (0.87)	5(1.23)	3 (0.92)	6.20 (1.11)	20.7 (0.036)
D9	7 (0.83)	2 (1.31)	8 (0.71)	12 (0.75)	10 (0.53)	7.80 (0.83)	14.21 (0.084)
H7	4 (1.10)	5 (1.36)	0 (0)	5 (1.10)	1 (0.26)	3.00 (0.76)	5.52 (0.360)
K7	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.00 (0.00)	0 (0)
N2	8 (0.63)	11 (0.64)	12 (0.80)	5 (1.13)	13 (0.87)	9.80 (0.81)	10.69 (0.040)
Reference (R) Location							
Troup Creek	6 (0.98)	6 (0.76)	8 (0.68)	7 (0.70)	4 (0.99)	5.80 (0.82)	1.21 (0.022)

2. Cochran's (C) test for homogeneity of variances of amphipod survival[c]
(No further statistical analysis required for amphipod weight since mean weight of surviving amphipods exposed to sediment from the site and reference location was from 0.76 to 1.11 mg, which was greater than weight of control organisms (0.54 mg)

$$C_{(cal.)} = s^2(\text{max.}) / s^2(\text{total})$$

$$C_{(cal.)} = 20.70 / 58.53 = 0.35 \text{ ns},$$

as compared to $C_{(tab.)} = 0.43$
for $k = 7$ and $v = 4$

3. Parametric one-way analysis of variance (ANOVA) followed by Tukey's (w) test of amphipod survival[d]

Source of variation in survival	Degrees of freedom (df)	Sum of squares (SS)	Mean square (MS)	F(cal.)
Sediment source (S)	s - 1 = 6	633.54	105.59	12.63 **,
Error (R)	s (r - 1) = 28	234.00	8.36	
Total (T)	sr - 1 = 34	867.54		

as compared to $F_{(tab.)} = 3.53$ for $P = 0.01$, 6 numerator df, and 28 denominator df

Sediment source (S):	K7	H7	Troup Creek	B7	D9	N2	Control
Mean ($\bar{x}$) survival:	0	3.00	5.80	6.20	7.80	9.80	14.20

$w_{(P = 0.05)}$ = q (square root of error MS / r)
= 4.49 (square root of 8.36 / 5)
= 5.79

[a]Surface sediment (0 - 15 cm in depth) employed in amphipod toxicity test was collected during the period of October 16 - 19, 2000. Laboratory control sediment was obtained from Boulder Reservoir and consisted of organic material and sand. Laboratory dilution water was formulated with artificial sea salt to a salinity of 20 ppt.

[b]Each replicate (r) consisted of 20 amphipods at start of test (i. e., 20 amphipods at end of test = 100% survival).

[c]Cochran's (C) test, when applied to amphipod survival data indicated homogeneity of variances (as indicated by the symbol "ns"). Consequently, further statistical analyses were conducted with original (untransformed) data by parametric protocols.

[d]A parametric ANOVA applied to amphipod survival data documented the presence of statistically significant differences in survival (as indicated by the symbol "**" for $F_{(cal.)}$). Tukey's (w) test indicates that a major source of these differences is the relatively low survival of amphipods exposed to sediment from Stations K7 and H7. In Tukey's test, survival data underscored by the same horizontal line are not significantly different (i. e., $x_1 - x_2 < w$ value of 5.79), whereas data not underscored by the same horizontal line are significantly different ($x_1 - x_2 > w$ value of 5.79).

Table 10.__Statistical analysis of survival and reproduction of grass *shrimp (Palaemonetes pugio)* exposed for 2 months to creek surface sediment of estuary at LCP Site[a]

A. SURVIVAL OF SHRIMP (JUVENILE TO ADULT)

1. Raw survival data (% survival)

Sediment source (S)	Replicate – r 1	2	3	Mean (x)	Variance (s2)
Control (Skidaway River)	96	92	92	93.3	5.34
Marsh Grid (from north to south)					
B7	96	88	96	93.3	21.34
D9	88	84	76	82.7	37.33
H7	88	96	84	89.3	37.33
K7	72	80	76	76.0	16.00
N2	88	72	68	76.0	111.94
Southern Part of Site					
Main Canal (5)	88	72	80	80.0	64.00
Eastern Creek (7)	68	80	84	77.3	69.39
Mouth of Purvis Creek (16)	64	72	80	72.0	64.00
Northern Part of Site					
Near old oil-processing site (33)	88	88	76	84.0	48.02
Reference (R) Locations					
Troup Creek (TC)	88	84	92	88.0	16.00
Crescent River (CR)	96	84	96	92.0	48.02

2. Cochran's (C) test for homogeneity of variances of survival data[b]

$C_{(cal.)} = s^2(\text{max.}) / s^2(\text{total})$

$C_{(cal.)} = 111.94 / 538.71 = 0.21$ ns,
as compared to $C_{(tab.)} = 0.39$
for $k = 12$ and $v = 2$

3. Parametric one-way analysis of variance (ANOVA) followed by Tukey's (w) test of survival data[c]

Source of variation in survival	Degrees of freedom (df)	Sum of squares (SS)	Mean square (MS)	$F_{(cal.)}$
Sediment source (S)	s - 1 = 11	1,846.67	167.88	3.74 **,
Error (R)	s (r - 1) = 24	1,077.33	44.89	
Total (T)	sr - 1 = 35	2,924.00		as compared to $F_{(tab.)} = 3.10$ for P = 0.01, 11 numerator df, and 24 denominator df

Sediment source (S):	16	K7	N2	7	5	D9	33	TC	H7	CR	B7	Cont.
Mean (x) survival (%):	72.0	76.0	76.0	77.3	80.0	82.7	84.0	88.0	89.3	92.0	93.3	93.3

$w_{(P = 0.05)} = q$ (square root of error MS / r)
= 5.10 (square root of 44.89 / 3)
= 19.7

[a]Surface sediment (0 - 15 cm in depth) employed in grass shrimp toxicity test was collected during the period of October16 - 19, 2000. Laboratory dilution water was estuarine water.

[b]Cochran's (C) test, when applied to grass shrimp survival data indicated homogeneity of variances (as indicated by the symbol "ns"). Consequently, further statistical analyses were conducted with original (untransformed) data by parametric protocols.

[c]A parametric ANOVA applied to grass shrimp survival data documented the presence of statistically significant differences in survival (as indicated by the symbol "**" for $F_{(cal.)}$). Tukey's (w) test indicates that a major source of these differences is the relatively low survival of grass shrimp exposed to sediment from Station 16 in comparison to control survival. In Tukey's test, survival data underscored by the same horizontal line are not significantly different (i. e., $x_1 - x_2 < w$ value of 19.7), whereas data not underscored by the same horizontal line are significantly different ($x_1 - x_2 > w$ value of 19.7).

Table 10.__Continued

B. PERCENT OF SURVIVING FEMALES FORMING MATURE OVARIES

1. Raw data (% females)

Sediment source (S)	Replicate – r: 1	2	3	Mean ($\bar{x}$)	Variance (s^2)
Control (Skidaway River)	76	84	60	73.3	149.33
Marsh Grid (from north to south)					
B7	44	76	52	57.3	277.22
D9	72	60	56	62.7	69.39
H7	68	44	32	48.0	335.99
K7	48	56	76	60.0	202.21
N2	60	52	80	64.0	202.21
Southern Part of Site					
Main Canal (5)	32	12	16	20.0	111.94
Eastern Creek (7)	52	12	32	32.0	400.00
Mouth of Purvis Creek (16)	68	40	76	61.3	357.21
Northern Part of Site					
Near old oil-processing site (33)	84	68	76	76.0	64.00
Reference (R) Locations					
Troup Creek (TC)	52	60	44	52.0	64.00
Crescent River (CR)	80	64	76	73.3	69.39

2. Cochran's (C) test for homogeneity of variances of data[d]

$C_{(cal.)} = s^2(\text{max.}) / s^2(\text{total})$

$C_{(cal.)} = 400.00 / 2{,}302.99 = 0.17$ ns,
as compared to $C_{(tab.)} = 0.39$
for k = 12, and v = 2

3. Parametric one-way analysis of variance (ANOVA) followed by Tukey's (w) test of data[e]

Source of variation	Degrees of freedom (df)	Sum of squares (SS)	Mean square (MS)	$F_{(cal.)}$
Sediment source (S)	s - 1 = 11	9,306.67	846.06	4.39 **,
Error (R)	s (r - 1) = 24	4,629.33	192.89	
Total (T)	sr - 1 = 35	13,936.00		as compared to $F_{(tab.)} = 3.10$ for P = 0.01, 11 numerator df, and 24 denominator df

Sediment source (S):	5	7	H7	TC	B7	K7	16	D9	N2	CR	Cont.	33
Mean (x) – (%):	20.0	32.0	48.0	52.0	57.3	60.0	61.3	62.7	64.0	73.3	73.3	76.0

$w_{(P = 0.05)}$ = q (square root of error MS / r)
= 5.10 (square root of 192.89 / 3)
= 40.9

[d]Cochran's (C) test, when applied to grass shrimp data indicated homogeneity of variances (as indicated by the symbol "ns"). Consequently, further statistical analyses were conducted with original (untransformed) data by parametric protocols.

[e]A parametric ANOVA applied to grass shrimp data documented the presence of statistically significant differences (as indicated by the symbol "**" for $F_{(cal.)}$). Tukey's (w) test indicates that a major source of these differences is the relatively low values for grass shrimp exposed to sediment from Stations 5 and 7 in comparison to the control value. In Tukey's test, data underscored by the same horizontal line are not significantly different (i. e., $x_1 - x_2 < w$ value of 40.9), whereas data not underscored by the same horizontal line are significantly different ($x_1 - x_2 > w$ value of 40.9).

Table 10.__Continued

C. PERCENT OF SURVIVING FEMALES PRODUCING EMBRYOS

1. Raw data (% females)

Sediment source (S)	Replicate – r: 1	2	3	Mean ($\bar{x}$)	Variance (s^2)
Control (Skidaway River)	80	52	76	69.3	229.22
Marsh Grid (from north to south)					
B7	44	40	60	48.0	111.94
D9	52	44	68	54.7	149.33
H7	0	0	0	0	0
K7	0	0	0	0	0.00
N2	52	44	40	45.3	37.33
Southern Part of Site					
Main Canal (5)	4	12	16	10.7	37.33
Eastern Creek (7)	4	20	8	10.7	69.39
Mouth of Purvis Creek (18)	44	52	36	44.0	64.00
Northern Part of Site					
Near old oil-processing site (33)	32	24	52	36.0	207.94
Reference (R) Locations					
Troup Creek (TC)	44	36	52	44.0	64.00
Crescent River (CR)	76	72	72	73.3	5.34

2. Cochran's (C) test for homogeneity of variances of data[f]

$C_{(cal.)} = s^2(\max.) / s^2(\text{total})$

$C_{(cal.)} = 229.22 / 975.82 = 0.23$ ns,
as compared to $C_{(tab.)} = 0.39$
for k = 12, and v = 2

3. Parametric one-way analysis of variance (ANOVA) followed by Tukey's (w) test of data[g]

Source of variation	Degrees of freedom (df)	Sum of squares (SS)	Mean square (MS)	$F_{(cal.)}$
Sediment source (S)	s - 1 = 11	21,260.00	1,932.73	23.76 **,
Error (R)	s (r - 1) = 24	1,952.00	81.33	
Total (T)	sr - 1 = 35	23,212.00		as compared to $F_{(tab.)} = 3.10$ for P = 0.01, 11 numerator df, and 24 denominator df

Sediment source (S):	H7	K7	5	7	33	18	TC	N2	B7	D9	Cont.	CR
Mean ($\bar{x}$) – (%):	0	0	10.7	10.7	36.0	44.0	44.0	45.3	48.0	54.7	69.3	73.3

$w_{(P = 0.05)} = q$ (square root of error MS / r)
$= 5.10$ (square root of 81.33 / 3)
$= 26.6$

[f]Cochran's (C) test, when applied to grass shrimp data indicated homogeneity of variances (as indicated by the symbol "ns"). Consequently, further statistical analyses were conducted with original (untransformed) data by parametric protocols.

[g]A parametric ANOVA applied to grass shrimp data documented the presence of statistically significant differences (as indicated by the symbol "**" for $F_{(cal.)}$). Tukey's (w) test indicates that a major source of these differences is the relatively low values for grass shrimp exposed to sediment from Stations H7, K7, 5, and 7 in comparison to most other values. In Tukey's test, data underscored by the same horizontal line are not significantly different (i. e., $x_1 - x_2 < w$ value of 26.6), whereas data not underscored by the same horizontal line are significantly different ($x_1 - x_2 > w$ value of 26.6).

Table 10.__Continued

D. PERCENT OF EMBRYOS HATCHING

1. Raw data (% hatching)

Sediment source (S)	Replicate – r: 1	2	3	Mean ($\bar{x}$)	Variance (s^2)
Control (Skidaway River)	96	96	88	93.3	21.34
Marsh Grid (from north to south)					
B7	92	96	88	92.0	16.00
D9	80	88	96	88.0	64
H7	0	0	0	0	0
K7	0	0	0	0	0
N2	92	88	76	85.3	69.39
Southern Part of Site					
Main Canal (5)	0	0	0	0	0
Eastern Creek (7)	0	0	0	0	0
Mouth of Purvis Creek (16)	76	88	64	76.0	144.00
Northern Part of Site					
Near old oil-processing site (33)	36	52	28	38.7	149.33
Reference (R) Locations					
Troup Creek (TC)	76	88	88	84.0	48.02
Crescent River (CR)	100	96	92	96.0	16

2. Cochran's (C) test for homogeneity of variances of data[h]

$C_{(cal.)} = s^2(\text{max.}) / s^2(\text{total})$

$C_{(cal.)} = 149.33 / 528.08 = 0.28$ ns,
as compared to $C_{(tab.)} = 0.39$
for $k = 12$, and $v = 2$

3. Parametric one-way analysis of variance (ANOVA) followed by Tukey's (w) test of data[i]

Source of variation	Degrees of freedom (df)	Sum of squares (SS)	Mean square (MS)	$F_{(cal.)}$
Sediment source (S)	s - 1 = 11	60,520.89	5,501.90	125.04 **,
Error (R)	s (r - 1) = 24	1,056.00	44	
Total (T)	sr - 1 = 35	61,576.89		as compared to $F_{(tab.)} = 3.10$ for P = 0.01, 11 numerator df, and 24 denominator df

Sediment source (S):	H7	K7	5	7	33	16	TC	N2	D9	B7	Cont.	CR
Mean ($\bar{x}$) – (%):	0	0	0	0	38.7	76.0	84.0	85.3	88.0	92.0	93.3	96.0

$w_{(P = 0.05)}$ = q (square root of error MS / r)
= 5.10 (square root of 44.00 / 3)
= 19.5

[h]Cochran's (C) test, when applied to grass shrimp data indicated homogeneity of variances (as indicated by the symbol "ns"). Consequently, further statistical analyses were conducted with original (untransformed) data by parametric protocols.

[i]A parametric ANOVA applied to grass shrimp data documented the presence of statistically significant differences (as indicated by the symbol "**" for $F_{(cal.)}$). Tukey's (w) test indicates that a major source of these differences is the relatively low values for grass shrimp exposed to sediment from Stations H7, K7, 5, 7, and 33 in comparison to most other values. In Tukey's test, data underscored by the same horizontal line are not significantly different (i. e., $x_1 - x_2 < w$ value of 19.5), whereas data not underscored by the same horizontal line are significantly different ($x_1 - x_2 > w$ value of 19.5).

Table 11.__ Coefficients of determination for relationships between chemistry and toxicity of creek surface sediment of estuary at LCP Site[a]

Relationship		Linear coefficient of determination
Concentration of major chemical of potential concern (COPC)[b]	Toxicological endpoint evaluated	$(r^2)^{c, d}$
Amphipod (*Leptocheirus plumulosus*) Study[e]		
Total mercury	Survival of Amphipods	Opposite relationship
Total mercury norm. to fines	----	Opposite relationship
Methylmercury	----	Opposite relationship
Methylmercury norm. to fines	----	Opposite relationship
Aroclor 1268	----	0.03
Aroclor 1268 norm to fines	----	0.04
Aroclor 1268 norm. to fines and TOC	----	0.03
Lead	----	0.42
Lead norm. to fines	----	0.54
Total PAHs (Method 1)	----	0.55
Total PAHs(Method 1) norm. to fines	----	0.55
Total PAHs (Method 2)	----	0.56
Total PAHs(Method 2) norm. to fines	----	0.55
Grass Shrimp (*Palaemonetes pugio*) Study[f]		
Total mercury	A. Survival of Shrimp (Juvevile to Adult)	0.10
Total mercury norm. to fines	----	0.14
Methylmercury		0.10
Methylmercury norm. to fines	----	0.16
Aroclor 1268	----	Opposite relationship
Aroclor 1268 norm to fines	----	Opposite relationship
Aroclor 1268 norm. to fines and TOC	----	0.00
Lead	----	0.02
Lead norm. to fines	----	Opposite relationship
Total PAHs (Method 1)	----	0.10
Total PAHs(Method 1) norm. to fines	----	Opposite relationship
Total PAHs (Method 2)	----	0.08
Total PAHs(Method 2) norm. to fines	----	0.05

Table 11.__ Continued

Relationship: Concentration of major chemical of potential concern (COPC)[b]	Relationship: Toxicological endpoint evaluated	Linear coefficient of determination $(r^2)^{c, d}$
	Grass Shrimp (*Palaemonetes pugio*) Study[f] – Continued	
Total mercury	B. Percent of Surviving Females Forming Mature Ovaries	0.43
Total mercury norm. to fines	----	0.39
Methylmercury	----	Opposite relationship
Methylmercury norm. to fines	----	0.04
Aroclor 1268	----	0.27
Aroclor 1268 norm to fines	----	0.27
Aroclor 1268 norm. to fines and TOC	----	0.08
Lead	----	0.26
Lead norm. to fines	----	Opposite relationship
Total PAHs (Method 1)	----	Opposite relationship
Total PAHs(Method 1) norm. to fines	----	Opposite relationship
Total PAHs (Method 2)	----	Opposite relationship
Total PAHs(Method 2) norm. to fines	----	Opposite relationship
Total mercury	C. Percent of Surviving Females Producing Embryos	0.17
Total mercury norm. to fines	----	0.16
Methylmercury	----	Opposite relationship
Methylmercury norm. to fines	----	Opposite relationship
Aroclor 1268	----	0.20
Aroclor 1268 norm to fines	----	0.20
Aroclor 1268 norm. to fines and TOC	----	0.04
Lead	----	0.69
Lead norm. to fines	----	0.01
Total PAHs (Method 1)	----	0.20
Total PAHs(Method 1) norm. to fines	----	Opposite relationship
Total PAHs (Method 2)	----	0.21
Total PAHs(Method 2) norm. to fines	----	0.08

Table 11.__ Continued

Relationship: Concentration of major chemical of potential concern (COPC)[b]	Relationship: Toxicological endpoint evaluated	Linear coefficient of determination (r^2)[c, d]
<u>Grass Shrimp (*Palaemonetes pugio*) Study[f] – Continued</u>		
Total mercury	D. Percent of Embryos Hatching	0.20
Total mercury norm. to fines	----	0.18
Methylmercury	----	Opposite relationship
Methylmercury norm. to fines	----	Opposite relationship
Aroclor 1268	----	0.18
Aroclor 1268 norm to fines	----	0.18
Aroclor 1268 norm. to fines and TOC	----	0.03
Lead	----	0.54
Lead norm. to fines	----	0.05
Total PAHs (Method 1)	----	0.14
Total PAHs(Method 1) norm. to fines	----	0.01
Total PAHs (Method 2)	----	0.13
Total PAHs(Method 2) norm. to fines	----	0.07

[a]Creek surface sediment was 0 - 15 cm in depth.

[b]In Method 1 for total PAHs, only detected PAHs are addressed. Method 2 reflects concentrations of detected PAHs plus 1/2 of the detection limits for non-detected PAHs.

[c]Coefficient of determination (r^2) describes the percent of variability in toxicological endpoints that can be explained by variation in chemical concentrations. The term "opposite relationship" refers to cases where increased toxicity is associated with decreased chemical concentrations.

[d]Toxicity reflected in this table could be associated with chemicals other than major COPC. For, example, numerous metals other than mercury and lead were present in sediment, and dioxin was not evaluated in sediment. Conversely, semivolatile organic chemicals (SVOCs) and pesticides were almost never detected in sediment (Appendix C of Volume II of this report).

[e]The amphipod study (Table 9) was conducted with sediment from five creek sampling stations in the Marsh Grid (Stations B7, D9, H7, K7, and N2) and the Troup Creek reference location.

[f]The grass shrimp study (Table 10) was conducted with sediment from five creek sampling stations in the Marsh Grid (Stations B7, D9, H7, K7, and N2), three stations in the southern part of the site (Stations 5, 7, and 16), one station in the northern part of the site (Station 33), as well as the Troup Creek and Crescent River reference locations.

Table 12.__Selected community characteristics of benthic macroinvertebrates in

Sampling station	Background information		Macrobenthos characteristics					
	Silt and clay (%)	Total organic content (%)	Total number of taxa	Total number of individuals	Density of individuals (no./m2)	Shannon-Weaver diversity index (d)	Lloyd-Ghelardi equitability index (e)	Major taxonomic groups: % individuals (Cnidaria = C; Platyhelminthes = P; Rhynchocoela = R; Annelida = An; Mollusca = M; Arthropoda = Ar)
Southern Part of Site								
Main canal (5)	90	6.5	5	30	435	1.46	1.18	An = 67%; M = 33%
Eastern Creek (7)	96	6.7	14	312	4,500	1.62	0.50	An = 95%; R = 2%; M = 1.5%; Ar = 1.5%
Mouth of Purvis Creek (16)	17	1.0	16	125	1,800	2.20	0.80	An = 80%; Ar = 11%; M = 9%
Northern Part of Site								
Near old oil-processing site (33)	6.6	0.90	9	31	449	1.95	1.09	An = 68%; M = 29%; Ar = 3%
Reference Locations								
Troup Creek	44	2.1	23	107	1,600	2.63	0.87	An = 67%; Ar = 28%; C = 3%; M = 2%
Crescent River	8.2	0.33	12	107	1,600	1.74	0.66	An = 79%; C = 16%; Ar = 3%; R = 2%

[a]Macrobenthos were collected with a Petite Ponar grab sampler (down to a sediment depth of about 15 cm) during the period of October 11 - 19, 2000. Three replicate macrobenthos samples were collected at each sampling station. Macrobenthos data presented in this table reflect all three replicates.

Table 13.__Exposure assumptions for predators exposed to major chemicals of potential concern (COPC) in environmental media of estuary at LCP Site

Predator	Body weight (kg, wet wt)[a]	Diet[b]	Food ingestion rate (kg, dry wt/day[c]	Sediment ingestion rate (kg, dry wt/day)[d]	Water ingestion rate (L/day)[e]	Time-use factor (TUF)	Area-use factor (AUF)[f]
			Fishes				
Red drum (Age group II)	2.0	40% mummichogs 30% fiddler crabs 30% blue crabs	0.04 – wet wt (2% of body weight)	0 (estimate not available)	0 (estimate not available)	1 (year-round resident)	1
			Reptiles				
Diamondback terrapin	0.14	90% fiddler crabs 10% mummichogs	0.00059 (0.4% of body weight)	0.000027 (4.6% of food rate)	0 (estimate not available)	1 (year-round resident)	1
			Birds				
Red-winged blackbird	0.037	90% insects 10% fiddler crabs	0.0086 (23% of body weight)	0.00017 (2% of food rate)	0.0065	1 (year-round resident)	1
Clapper rail	0.28	85% fiddler crabs 10% insects 5% mummichogs	0.025 (9% of body weight)	0.0025 (10% of food rate)	0.025	1 (year-round resident)	1
Green heron	0.20	90% mummichogs 5% blue crabs 5% fiddler crabs	0.024 (12% of body weight)	0.00048 (2% of food rate)	0.023	1 (year-round resident)	1
			Mammals				
Marsh rabbit	1.0	100% cordgrass	0.088 (9% of body weight)	0.0018 (2% of food rate)	0.099	1 (year-round resident)	1
Raccoon	3.7	45% fiddler crabs 45% blue crabs 10% mummichogs	0.20 (5% of body weight)	0.019 (9.4% of food rate)	0.32	1 (year-round resident)	1 and 0.3
River otter	6.7	30% mummichogs 50% silver perch 10% fiddler crabs 10% blue crabs	0.33 (5% of body weight)	0.015 (4.5% of food rate)	0.55	1 (year-round resident)	1 and 0.66

[a]Body weights for the raccoon and river otter are derived from USEPA's (1993) wildlife exposure factors handbook. Body weights for other predators are derived from the general scientific literature: red drum (Evans and Engel, 1994), diamondback terrapin (Allen and Littleford, 1955), red-winged blackbird (Orians, 1961), clapper rail (USGS, Undated), green heron (U. Guelph, 2000), and marsh rabbit (U. Michigan, 1999). Whenever available, body weights for adult females (to which most toxicity reference values apply) indigenous to Georgia or the southeastern United States are reported.

[b]Diets of predators are usually representative of diets reported in the general scientific literature, but are limited to food items that were collected in this investigation.

[c]Food ingestion rate of the red drum is derived from Evans and Engel (1994). Food ingestion rates of other predators are derived as functions of wildlife body weights by the allometric equations developed by Nagy (1987). Specific equations employed are – 1) diamondback terrapin: equation for insectivorous lizards, the only available equation); 2) red-winged blackbird: equation for passerine birds; 3) clapper rail and green heron: equation for "all birds;" 4) marsh rabbit: equation for herbivorous mammals; and 5) raccoon and river otter: equation for "all eutherians."

[d]Sediment ingestion rates of predators are derived as functions of predator food ingestion rates according to the general relationships developed by Beyer et al. (1994).

[e]Water ingestion rates of preedators are derived as functions of predator body weights by the allometric equations developed by the USEPA (1993) for birds and mammals.

[f]AUFs other than 1 are based on the following vital statistics of affected predators:

- Raccoon: utilizes marsh habitat only about 30% of the time, with remainder of the time distributed between grassy/shrub and wooded areas (Harman and Stains (1979), thereby justifying an AUF of 0.3 for the LCP Site
- River otter: 295 ha of female foraging area (Foy, 1984) vs. 195 ha of marsh at the LCP Site = AUF of 0.66

Table 14._Toxicity reference values (TRVs) for predators exposed to major chemicals of potential concern (COPC) in environmental media of estuary at LCP Site

Predator	Major chemical of potential concern (COPC)	Type of TRV[a]	Reference/comments[a]
Fishes (red drum)	Methylmercury	LOAEL = 0.30	Median highest LOAEL reported for 7 species of mostly freshwater fishes monitored for various toxicological effects (as reviewed by Dillon, 2001)
		NOAEL = 0.15	Median highest NOAEL reported for 7 species of mostly freshwater fishes monitored for various toxicological effects (as reviewed by Dillon, 2001)
	PCBs (Aroclor 1268)	LOAEL = 15 NOAEL = 1.6	Study (40 days exposure and 300 days subsequent monitoring) of marine minnow reproduction after exposure to **Clophen A50** (Bengtsson, 1980; as identified by Huston, 2001)
Reptiles (diamond-back terrapin)	Inorganic mercury	LOAEL = 35 NOAEL = 17.5	Assume LOAEL and NOAEL derived for birds exposed to inorganic mercury are applicable to reptiles
	Methylmercury	LOAEL = 5	Study of single gavage dose of chemical to juvenile alligators interpreted by Sprenger et al. (1997)
		NOAEL = 0.5	LOAEL-to-NOAEL uncertainty factor of 10 applied to alligator LOAEL
	PCBs (Aroclor 1268)	LOAEL = 3.2	Study (3 weeks) of Caspian terrapin metabolism after exposure to **Aroclor 1254** (Yawetx et al., 1983) interpreted by Sprenger et al. (1997)
		NOAEL = 0.32	LOAEL-to-NOAEL uncertainty factor of 10 applied to terrapin LOAEL
	Lead	LOAEL = 2.8 NOAEL = 0.28	Assume LOAEL and NOAEL derived for birds exposed to lead are applicable to reptiles
	PAHs (Total PAHs)	LOAEL = 13.7 NOAEL = 1.4	Assume LOAEL and NOAEL derived for birds exposed to PAHs are applicable to reptiles
Birds (red-winged blackbird, clapper rail, green heron)	Inorganic mercury	LOAEL = 35 NOAEL =17.5	Assumptions pertaining to ingestion rate and body weight applied to study of chicken reproduction (Scott, 1977)
	Methylmercury	LOAEL = 0.078	Three-generation study of mallard reproduction (Heinz, 1979)
		NOAEL = 0.039	Mallard LOAEL / 2 (UF_L recommended by USEPA, 1995)
	PCBs (Aroclor 1268)	NOAEL = 1.3	Study (9 weeks) of weight gain, livability, fertility, egg weight, and egg-shell thickness of chickens after exposure to **Aroclor 1268** (Lillie et al., 1974; as identified by Huston, 2001)
		LOAEL = 13	NOAEL-to-LOAEL adjustment factor of 10 applied to chicken NOAEL
	Lead	NOAEL = 0.28	Study (11 days) of European starling survival (Osborn et al., 1983) / 10 (subchronic-to-chronic uncertainty factor)
		LOAEL = 2.8	NOAEL-to-LOAEL adjustment factor of 10 applied to starling NOAEL
	PAHs (Total PAHs)	LOAEL = 13.7	Study (5 days) of lymphocyte blastogenesis in adult starlings exposed to 7, 12 - DMBA, a high-molecular-weight PAH (Trust et al., 1994; as interpreted by Huston, 2001)
		NOAEL = 1.4	LOAEL-to-NOAEL adjustment factor of 10 applied to starling LOAEL
Mammals (marsh rabbit, raccoon, river otter)	Inorganic mercury	NOAEL = 14 LOAEL = 140	Study (2 years) of rat reproduction and development (Fitzhugh et al.,1950) NOAEL-to-LOAEL adjustment factor of 10 applied to rat NOAEL
	Methylmercury	LOAEL = 0.027 NOAEL = 0.016	Study (93 days) of survival, anorexia, and ataxia of mink (Wobeser et al., 1976) / 10 (UF_S recommended by USEPA, 1995)
	PCBs (Aroclor 1268)	LOAEL =0.3	Study (297 days) of mink reproduction after exposure to **Aroclor 1254** (Aulerich and Ringer, 1977)
		NOAEL = 0.03	Mink LOAEL for Aroclor 1254 / 10 (UF_L recommended by USEPA, 1995)

Table 14.__Continued

Predator	Major chemical of potential concern (COPC)	Type of TRV[a]	Reference/comments[a]
Mammals (marsh rabbit, raccoon, river otter) -- Continued	Lead	LOAEL = 0.32	Study of chronic dog toxicity (Demayo et al., 1982)
		NOAEL =0.032	LOAEL-to-NOAEL uncertainty factor of 10 applied to dog LOAEL
	PAHs	LOAEL = 10	Study (10 days of adult female exposure and 42 days of subsequent monitoring of young) of fertility of mice exposed to benzo(a)pyrene, a high-molecular-weight PAH (MacKenzie and Angevine, 1981; as identified by Huston, 2001)
		NOAEL = 1	LOAEL-to-NOAEL adjustment factor of 10 applied to mouse LOAEL

[a]Acronyms employed in this column are -- NOAEL (no observed adverse effect level), LOAEL (lowest observed adverse effect level), UF_L (LOAEL-to-NOAEL uncertainty factor), and UF_S (subchronic-to-chronic uncertainty factor). Unit of measurement for avian, mammalian, and reptilian TRVs is mg/kg BW/day. Unit of measurement for fish TRVs is mg/kg (wet wt).

Table 15.__Mean estimated environmental exposures (EEEs), toxicity reference values (TRVs), and associated hazard quotients (HQs) for predators exposed to major chemicals of potential concern (COPC) in environmental media of estuary at LCP Site[a]

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Mean estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Mean hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
	Red Drum (*Sciaenops ocellatus*)					
Methyl-mercury	Purvis Creek	0.74	0.30	0.15	2.5	4.9
	Reference Locations					
	Troup Creek	0.04	0.30	0.15	0.13	0.27
	Crescent River	0.04	0.30	0.15	0.13	0.27
Aroclor 1268	Purvis Creek	3.2	15	1.6	0.21	2.0
	Reference Locations					
	Troup Creek	0.41	15	1.6	0.027	0.26
	Crescent River	0.47	15	1.6	0.031	0.29
	Diamondback terrapin (*Malaclemys terrapin*)					
Inorganic mercury	Southern Part of Site					
	By "AB" seepage from land	0.0021	35	17.5	0.000060	0.00012
	Main Canal -- upstream (25)	0.0018	35	17.5	0.000051	0.00010
	Mouth of Purvis Creek (28)	0.00029	35	17.5	0.0000083	0.000017
	Reference Locations					
	Troup Creek	0.000071	35	17.5	0.0000020	0.0000041
	Crescent River	0.000024	35	17.5	0.00000069	0.0000014
Methyl-mercury	Southern Part of Site					
	By "AB" seepage from land	0.0025	5	0.5	0.00050	0.0050
	Main Canal -- upstream (25)	0.0017	5	0.5	0.00034	0.0034
	Mouth of Purvis Creek (28)	0.00060	5	0.5	0.00012	0.0012
	Reference Locations					
	Troup Creek	0.00012	5	0.5	0.000024	0.00024
	Crescent River	0.000061	5	0.5	0.000012	0.00012
Aroclor 1268	Southern Part of Site					
	By "AB" seepage from land	0.012	3.2	0.32	0.0038	0.038
	Main Canal -- upstream (25)	0.0084	3.2	0.32	0.0026	0.026
	Mouth of Purvis Creek (28)	0.0025	3.2	0.32	0.00078	0.0078
	Reference Locations					
	Troup Creek	0.00069	3.2	0.32	0.00022	0.0022
	Crescent River	0.00075	3.2	0.32	0.00023	0.0023
Lead	Southern Part of Site					
	By "AB" seepage from land	0.108	2.8	0.28	0.039	0.39
	Main Canal -- upstream (25)	0.011	2.8	0.28	0.0039	0.039
	Reference Locations					
	Troup Creek	0.0094	2.8	0.28	0.0034	0.034
	Crescent River	0.0065	2.8	0.28	0.0023	0.023
	Red-Winged Blackbird (*Agelaius phoeniceus*)					
Inorganic mercury	Southern Part of Site					
	Main canal -- downstream (26)	0.020	35	17.5	0.00057	0.0011
Methyl-mercury	Southern Part of Site					
	Main canal -- downstream (26)	0.012	0.078	0.039	0.15	0.31
Aroclor 1268	Southern Part of Site					
	Main canal -- downstream (26)	0.072	13	1.3	0.0055	0.055
Lead	Southern Part of Site					
	Main canal -- downstream (26)	0.38	2.8	0.28	0.14	1.4

Table 15.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Mean estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Mean hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
		Clapper Rail (*Rallus longirostris*)				
Inorganic mercury	Southern Part of Site					
	By "AB" seepage from land	0.041	35	17.5	0.0012	0.0023
	Main Canal -- upstream (25)	0.037	35	17.5	0.0011	0.0021
	Mouth of Purvis Creek (28)	0.0083	35	17.5	0.00024	0.00047
	Reference Locations					
	Troup Creek	0.0028	35	17.5	0.000083	0.00017
	Crescent River	0.00045	35	17.5	0.000013	0.000026
Methyl-mercury	Southern Part of Site					
	By "AB" seepage from land	0.048	0.078	0.039	0.62	**1.2**
	Main Canal -- upstream (25)	0.030	0.078	0.039	0.38	0.77
	Mouth of Purvis Creek (28)	0.011	0.078	0.039	0.14	0.28
	Reference Locations					
	Troup Creek	0.0027	0.078	0.039	0.035	0.069
	Crescent River	0.0013	0.078	0.039	0.017	0.033
Aroclor 1268	Southern Part of Site					
	By "AB" seepage from land	0.24	13	1.3	0.018	0.18
	Main Canal -- upstream (25)	0.17	13	1.3	0.013	0.13
	Mouth of Purvis Creek (28)	0.049	13	1.3	0.0038	0.038
	Reference Locations					
	Troup Creek	0.015	13	1.3	0.0012	0.012
	Crescent River	0.016	13	1.3	0.0012	0.012
Lead	Southern Part of Site					
	By "AB" seepage from land	2.9	2.8	0.28	1.0	**10**
	Main Canal -- upstream (25)	0.30	2.8	0.28	0.11	**1.1**
	Reference Locations					
	Troup Creek	0.32	2.8	0.28	0.11	**1.1**
	Crescent River	0.16	2.8	0.28	0.057	0.57

Table 15.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Mean estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Mean hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
	Green Heron (*Butorides striatus*)					
Inorganic mercury	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.27	35	17.5	0.0077	0.015
	Eastern Creek -- downstream (9)	0.0050	35	17.5	0.00014	0.00029
	Western Creek Complex (13)	0.017	35	17.5	0.00049	0.00097
	Northern Part of Site					
	Near old oil-processing site (33)	0.0026	35	17.5	0.000074	0.00015
	Reference Locations					
	Troup Creek	0.00060	35	17.5	0.000017	0.000034
	Crescent River	0.000052	35	17.5	0.0000015	0.0000030
Methyl-mercury	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.058	0.078	0.039	0.74	1.5
	Eastern Creek -- downstream (9)	0.098	0.078	0.039	1.3	2.5
	Western Creek Complex (13)	0.050	0.078	0.039	0.64	1.3
	Northern Part of Site					
	Near old oil-processing site (33)	0.058	0.078	0.039	0.74	1.5
	Reference Locations					
	Troup Creek	0.0049	0.078	0.039	0.063	0.13
	Crescent River	0.0035	0.078	0.039	0.045	0.090
Aroclor 1268	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.24	13	1.3	0.018	0.18
	Eastern Creek -- downstream (9)	0.19	13	1.3	0.015	0.15
	Western Creek Complex (13)	0.098	13	1.3	0.0075	0.075
	Northern Part of Site					
	Near old oil-processing site (33)	0.10	13	1.3	0.0077	0.077
	Reference Locations					
	Troup Creek	0.026	13	1.3	0.0020	0.020
	Crescent River	0.024	13	1.3	0.0018	0.018
Lead	Southern Part of Site					
	Western Creek Complex (13)	0.24	2.8	0.28	0.086	0.86
	Northern Part of Site					
	Near old oil-processing site (33)	2.9	2.8	0.28	1.0	10
	Reference Locations					
	Troup Creek	0.34	2.8	0.28	0.12	1.2
	Crescent River	0.11	2.8	0.28	0.039	0.39

Table 15.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Mean estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c] LOAEL	NOAEL	Mean hazard quotient -- HQ (EEE / TRV)[d] LOAEL	NOAEL
	Marsh Rabbit (*Sylvilagus palustris*)					
Inorganic mercury	Southern Part of Site					
	Main Canal --upstream (25)	0.015	140	14	0.00011	0.0011
	Main Canal -- downstream (26)	0.0057	140	14	0.000041	0.00041
	Streamlet to Main Canal (19)	0.0035	140	14	0.000025	0.00025
	Eastern Creek (22)	0.041	140	14	0.00029	0.0029
	Western Creek Complex (27)	0.0074	140	14	0.000053	0.00053
	Mouth of Purvis Creek (28)	0.0029	140	14	0.000021	0.00021
	Northern Part of Site					
	Near old oil-processing site (40)	0.0038	140	14	0.000027	0.00027
	Northern Creek (42)	0.0040	140	14	0.000029	0.00029
	Western Part of Site					
	Mouth of central creek (46)	0.0036	140	14	0.000026	0.00026
	Reference Locations					
	Troup Creek	0.00086	140	14	0.0000061	0.000061
	Crescent River	0.00045	140	14	0.0000032	0.000032
Methyl-mercury	Southern Part of Site					
	Main Canal --upstream (25)	0.00053	0.027	0.016	0.020	0.033
	Main Canal -- downstream (26)	0.000099	0.027	0.016	0.0037	0.0062
	Streamlet to Main Canal (19)	0.00011	0.027	0.016	0.0041	0.0069
	Eastern Creek (22)	0.00067	0.027	0.016	0.025	0.042
	Western Creek Complex (27)	0.000063	0.027	0.016	0.0023	0.0039
	Mouth of Purvis Creek (28)	0.000080	0.027	0.016	0.0030	0.0050
	Northern Part of Site					
	Near old oil-processing site (40)	0.00024	0.027	0.016	0.0089	0.015
	Northern Creek (42)	0.00014	0.027	0.016	0.0052	0.0088
	Western Part of Site					
	Mouth of central creek (46)	0.00010	0.027	0.016	0.0037	0.0062
	Reference Locations					
	Troup Creek	0.000032	0.027	0.016	0.0012	0.0020
	Crescent River	0.000029	0.027	0.016	0.0011	0.0018
Aroclor 1268	Southern Part of Site					
	Main Canal -- upstream (25)	0.011	0.3	0.03	0.037	0.37
	Main Canal -- downstream (26)	0.022	0.3	0.03	0.073	0.73
	Eastern Creek (22)	0.023	0.3	0.03	0.077	0.77
	Reference locations					
	Troup Creek	0.017	0.3	0.03	0.057	0.57
	Crescent River	0.019	0.3	0.03	0.0063	0.63
Lead	Southern Part of Site					
	Main Canal --upstream (25)	0.34	0.32	0.032	1.1	11
	Main Canal -- downstream (26)	0.33	0.32	0.032	1.0	10
	Streamlet to Main Canal (19)	0.24	0.32	0.032	0.75	7.5
	Eastern Creek (22)	0.36	0.32	0.032	1.1	11
	Western Creek Complex (27)	0.25	0.32	0.032	0.78	7.8
	Mouth of Purvis Creek (28)	0.27	0.32	0.032	0.84	8.4
	Northern Part of Site					
	Near old oil-processing site (40)	0.69	0.32	0.032	2.2	22
	Northern Creek (42)	0.38	0.32	0.032	1.2	12
	Western Part of Site					
	Mouth of central creek (46)	0.32	0.32	0.032	1.0	10
	Reference Locations					
	Troup Creek	0.22	0.32	0.032	0.69	6.9
	Crescent River	0.31	0.32	0.032	0.97	9.7

Table 15.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Mean estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Mean hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
		Raccoon (*Procyon lotor*)[e]				
Inorganic mercury	Southern Part of Site					
	By "AB" seepage from land	0.015 / 0.0045	140	14	0.00011 / 0.000032	0.0011 / 0.00032
	Main Canal -- upstream (25)	0.014 / 0.0042	140	14	0.00010 / 0.000030	0.0010 / 0.00030
	Mouth of Purvis Creek (28)	0.0038 / 0.0011	140	14	0.000027 / 0.0000079	0.00027 / 0.000079
	Reference Locations					
	Troup Creek	0.0015 / 0.00045	140	14	0.000011 / 0.0000032	0.00011 / 0.000032
	Crescent River	0.00015 / 0.00045	140	14	0.0000011 / 0.0000032	0.000011 / 0.000032
Methyl-mercury	Southern Part of Site					
	By "AB" seepage from land	0.058 / 0.017	0.027	0.016	**2.1** / 0.63	**3.6 / 1.1**
	Main Canal -- upstream (25)	0.054 / 0.016	0.027	0.016	**2.0** / 0.59	**3.4 / 1.0**
	Mouth of Purvis Creek (28)	0.046 / 0.014	0.027	0.016	**1.7** / 0.52	**2.9** / 0.88
	Reference Locations					
	Troup Creek	0.0027 / 0.00081	0.027	0.016	0.10 / 0.030	0.17 / 0.051
	Crescent River	0.0025 / 0.00075	0.027	0.016	0.093 / 0.028	0.16 / 0.047
Aroclor 1268	Southern Part of Site					
	By "AB" seepage from land	0.10 / 0.030	0.3	0.03	0.33 / 0.10	**3.3 / 1.0**
	Main Canal -- upstream (25)	0.078 / 0.024	0.3	0.03	0.26 / 0.080	**2.6** / 0.80
	Mouth of Purvis Creek (28)	0.036 / 0.011	0.3	0.03	0.12 / 0.037	**1.2** / 0.37
	Reference Locations					
	Troup Creek	0.0088 / 0.0026	0.3	0.03	0.029 / 0.0087	0.29 / 0.087
	Crescent River	0.011 / 0.0033	0.3	0.03	0.037 / 0.011	0.37 / 0.11
Lead	Southern Part of Site					
	By "AB" seepage from land	1.3 / 0.39	0.32	0.032	**4.1 / 1.2**	**41 / 12**
	Main Canal -- upstream (25)	0.16 / 0.048	0.32	0.032	0.50 / 0.15	**5.0 / 1.5**
	Reference Locations					
	Troup Creek	0.18 / 0.054	0.32	0.032	0.56 / 0.17	**5.6 / 1.7**
	Crescent River	0.094 / 0.028	0.32	0.032	0.29 / 0.088	**2.9** / 0.88

Table 15.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Mean estimated exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Mean hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
		River Otter (*Lutra canadensis*)[f]				
Inorganic mercury	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.25 / 0.16	140	14	0.0018 / 0.0011	0.018 / 0.011
	Eastern Creek -- downstream (9)	0.0044 / 0.0029	140	14	0.000031 / 0.000021	0.00031 / 0.00021
	Western Creek Complex (13)	0.016 / 0.011	140	14	0.00011 / 0.000079	0.0011 / 0.00079
	Northern Part of Site					
	Near old oil-processing site (33)	0.0021 / 0.0014	140	14	0.000015 / 0.000010	0.00015 / 0.00010
	Reference Location					
	Troup Creek	0.00056 / 0.00037	140	14	0.0000040 / 0.0000026	0.000040 / 0.000026
Methyl-mercury	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.072 / 0.048	0.027	0.016	**2.7 / 1.8**	**4.5 / 3.0**
	Eastern Creek -- downstream (9)	0.076 / 0.050	0.027	0.016	**2.8 / 1.9**	**4.8 / 3.1**
	Western Creek Complex (13)	0.069 / 0.046	0.027	0.016	**2.6 / 1.7**	**4.3 / 2.9**
	Northern Part of Site					
	Near old oil-processing site (33)	0.072 / 0.048	0.027	0.016	**2.7 / 1.8**	**4.5 / 3.0**
	Reference Location					
	Troup Creek	0.0053 / 0.0035	0.027	0.016	0.20 / 0.13	0.33 / 0.22
Aroclor 1268	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.12 / 0.079	0.3	0.03	0.40 / 0.26	**4.0 / 2.6**
	Eastern Creek -- downstream (9)	0.11 / 0.073	0.3	0.03	0.37 / 0.24	**3.7 / 2.4**
	Western Creek Complex (13)	0.092 / 0.061	0.3	0.03	0.31 / 0.20	**3.1 / 2.0**
	Northern Part of Site					
	Near old oil-processing site (33)	0.097 / 0.064	0.3	0.03	0.32 / 0.21	**3.2 / 2.1**
	Reference Location					
	Troup Creek	0.013 / 0.0086	0.3	0.03	0.043 / 0.029	0.43 / 0.29
Lead	Southern Part of Site					
	Western Creek Complex (13)	0.11 / 0.073	0.32	0.032	0.34 / 0.23	**3.4 / 2.3**
	Northern Part of Site					
	Near old oil-processing site (33)	0.45 / 0.30	0.32	0.032	**1.4** / 0.94	**14 / 9.4**
	Reference Location					
	Troup Creek	0.10 / 0.066	0.32	0.032	0.31 / 0.21	**3.1 / 2.1**

[a]PAHs are not addressed in this table since PAHs were almost never detected in prey of predators and, when detected, usually occurred at less than reporting limits at the reference locations. Worksheets pertaining to this table are contained in Appendix I of Volume II of this report.

[b]Assumptions on which EEEs are based are presented in Table 13. EEE for red drum is expressed as mg/kg (wet wt).

[c]TRVs are reviewed in Table 14. TRVs for red drum is expressed as mg/kg (wet wt).

[d] HQs greater than 1 are identified in **bold print** in this table.

[e]EEEs, as well as LOAEL and NOAEL HQs, for raccoons are presented for an area-use-factor (AUF) of 1 (the values to the left of the "/" mark) and for an AUF of 0.3 (the values to the right of the "/").

[f]EEEs, as well as LOAEL and NOAEL HQs, for river otters are presented for an AUF of 1 (the values to the left of the "/" mark) and for an AUF of 0.66 (the values to the right of the "/").

ıle 16.__Maximum estimated environmental exposures (EEEs), toxicity reference values (TRVs), ınd associated hazard quotients (HQs) for predators exposed to major chemicals of potential :oncern (COPC) in environmental media of estuary at LCP Site[a]

Major ɜmical of ɔtential oncern ɔOPC)	Location in study area (sampling station)	Maximum estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Maximum hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
	Red Drum (*Sciaenops ocellatus*)					
hyl- ·cury	Purvis Creek	1.1	0.30	0.15	3.7	**7.3**
	Reference Locations					
	Troup Creek	0.06	0.30	0.15	0.20	0.40
	Crescent River	0.06	0.30	0.15	0.20	0.40
›clor ;8	Purvis Creek	4.3	15	1.6	0.29	**2.7**
	Reference Locations					
	Troup Creek	0.41	15	1.6	0.027	0.26
	Crescent River	0.47	15	1.6	0.031	0.29
	Diamondback terrapin (*Malaclemys terrapin*)					
·thyl- ɜrcury	Southern Part of Site					
	By "AB" seepage from land	0.0026	5	0.5	0.00052	0.0052
	Main Canal -- upstream (25)	0.0016	5	0.5	0.00032	0.0032
	Mouth of Purvis Creek (28)	0.00068	5	0.5	0.00014	0.0014
	Reference Locations					
	Troup Creek	0.00014	5	0.5	0.000028	0.00028
	Crescent River	0.000085	5	0.5	0.000017	0.00017
·oclor ?68	Southern Part of Site					
	By "AB" seepage from land	0.018	3.2	0.32	0.0056	0.056
	Main Canal -- upstream (25)	0.0096	3.2	0.32	0.0030	0.030
	Mouth of Purvis Creek (28)	0.0031	3.2	0.32	0.00097	0.0097
	Reference Locations					
	Troup Creek	0.00075	3.2	0.32	0.00023	0.0023
	Crescent River	0.00083	3.2	0.32	0.00026	0.0026
ead	Southern Part of Site					
	By "AB" seepage from land	0.13	2.8	0.28	0.046	0.46
	Main Canal -- upstream (25)	0.013	2.8	0.28	0.0046	0.046
	Reference Locations					
	Troup Creek	0.013	2.8	0.28	0.0046	0.046
	Crescent River	0.0082	2.8	0.28	0.0029	0.029
	Red-Winged Blackbird (*Agelaius phoeniceus*)					
Methyl- mercury	Southern Part of Site					
	Main canal -- downstream (26)	0.012	0.078	0.039	0.15	0.31
Aroclor 1268	Southern Part of Site					
	Main canal -- downstream (26)	0.076	13	1.3	0.0058	0.058
Lead	Southern Part of Site					
	Main canal -- downstream (26)	0.39	2.8	0.28	0.14	**1.4**

Table 16.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Maximum estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c] LOAEL	NOAEL	Maximum hazard quotient -- HQ (EEE / TRV)[d] LOAEL	NOAEL
	Clapper Rail (*Rallus longirostris*)					
Methyl-mercury	Southern Part of Site					
	By "AB" seepage from land	0.051	0.078	0.039	0.65	**1.3**
	Main Canal -- upstream (25)	0.032	0.078	0.039	0.41	0.82
	Mouth of Purvis Creek (28)	0.012	0.078	0.039	0.15	0.31
	Reference Locations					
	Troup Creek	0.0031	0.078	0.039	0.040	0.079
	Crescent River	0.0019	0.078	0.039	0.024	0.049
Aroclor 1268	Southern Part of Site					
	By "AB" seepage from land	0.34	13	1.3	0.026	0.26
	Main Canal -- upstream (25)	0.19	13	1.3	0.015	0.15
	Mouth of Purvis Creek (28)	0.060	13	1.3	0.0046	0.046
	Reference Locations					
	Troup Creek	0.016	13	1.3	0.0012	0.012
	Crescent River	0.018	13	1.3	0.0014	0.014
Lead	Southern Part of Site					
	By "AB" seepage from land	3.3	2.8	0.28	**1.2**	**12**
	Main Canal -- upstream (25)	0.34	2.8	0.28	0.12	**1.2**
	Reference Locations					
	Troup Creek	0.41	2.8	0.28	0.15	**1.5**
	Crescent River	0.20	2.8	0.28	0.071	0.71
	Green Heron (*Butorides striatus*)					
Methyl-mercury	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.064	0.078	0.039	0.82	**1.6**
	Eastern Creek -- downstream (9)	0.11	0.078	0.039	**1.4**	**2.8**
	Western Creek Complex (13)	0.057	0.078	0.039	0.73	**1.5**
	Northern Part of Site					
	Near old oil-processing site (33)	0.067	0.078	0.039	0.86	**1.7**
	Reference Locations					
	Troup Creek	0.0062	0.078	0.039	0.079	0.16
	Crescent River	0.0062	0.078	0.039	0.079	0.16
Aroclor 1268	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.36	13	1.3	0.028	0.28
	Eastern Creek -- downstream (9)	0.30	13	1.3	0.023	0.23
	Western Creek Complex (13)	0.13	13	1.3	0.010	0.10
	Northern Part of Site					
	Near old oil-processing site (33)	0.14	13	1.3	0.011	0.11
	Reference Locations					
	Troup Creek	0.027	13	1.3	0.0021	0.021
	Crescent River	0.027	13	1.3	0.0021	0.021
Lead	Southern Part of Site					
	Western Creek Complex (13)	0.35	2.8	0.28	0.12	**1.2**
	Northern Part of Site					
	Near old oil-processing site (33)	7.6	2.8	0.28	**2.7**	**27**
	Reference Locations					
	Troup Creek	0.68	2.8	0.28	0.24	**2.4**
	Crescent River	0.13	2.8	0.28	0.046	0.46

Table 16.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Maximum estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c]		Maximum hazard quotient -- HQ (EEE / TRV)[d]	
			LOAEL	NOAEL	LOAEL	NOAEL
	Marsh Rabbit (*Sylvilagus palustris*)					
Methyl-mercury	Southern Part of Site					
	Main Canal --upstream (25)	0.00058	0.027	0.016	0.021	0.036
	Main Canal -- downstream (26)	0.00012	0.027	0.016	0.0044	0.0075
	Streamlet to Main Canal (19)	0.00014	0.027	0.016	0.0052	0.0088
	Eastern Creek (22)	0.00086	0.027	0.016	0.032	0.054
	Western Creek Complex (27)	0.000082	0.027	0.016	0.0030	0.0051
	Mouth of Purvis Creek (28)	0.00011	0.027	0.016	0.0041	0.0069
	Northern Part of Site					
	Near old oil-processing site (40)	0.00026	0.027	0.016	0.0096	0.016
	Northern Creek (42)	0.00015	0.027	0.016	0.0056	0.0094
	Western Part of Site					
	Mouth of central creek (46)	0.00013	0.027	0.016	0.0048	0.0081
	Reference Locations					
	Troup Creek	0.000048	0.027	0.016	0.0018	0.0030
	Crescent River	0.000037	0.027	0.016	0.0014	0.0023
Aroclor 1268	Southern Part of Site					
	Main Canal -- upstream (25)	0.019	0.3	0.03	0.063	0.63
	Main Canal -- downstream (26)	0.035	0.3	0.03	0.12	1.2
	Eastern Creek (22)	0.028	0.3	0.03	0.093	0.93
	Reference locations					
	Troup Creek	0.020	0.3	0.03	0.067	0.67
	Crescent River	0.020	0.3	0.03	0.067	0.67
Lead	Southern Part of Site					
	Main Canal --upstream (25)	0.41	0.32	0.032	1.3	13
	Main Canal -- downstream (26)	0.46	0.32	0.032	1.4	14
	Streamlet to Main Canal (19)	0.26	0.32	0.032	0.81	8.1
	Eastern Creek (22)	0.39	0.32	0.032	1.2	12
	Western Creek Complex (27)	0.31	0.32	0.032	0.97	9.7
	Mouth of Purvis Creek (28)	0.31	0.32	0.032	0.97	9.7
	Northern Part of Site					
	Near old oil-processing site (40)	0.91	0.32	0.032	2.8	28
	Northern Creek (42)	0.53	0.32	0.032	1.7	17
	Western Part of Site					
	Mouth of central creek (46)	0.36	0.32	0.032	1.1	11
	Reference Locations					
	Troup Creek	0.25	0.32	0.032	0.78	7.8
	Crescent River	0.41	0.32	0.032	1.3	13

Table 16.__Continued

Major chemical of potential concern (COPC)	Location in study area (sampling station)	Maximum estimated environmental exposure -- EEE (mg/kg BW/day)[b]	Toxicity reference value --TRV (mg/ kg BW/day)[c] LOAEL	NOAEL	Maximum hazard quotient -- HQ (EEE / TRV)[d] LOAEL	NOAEL
		Raccoon (*Procyon lotor*)[e]				
Methyl-mercury	Southern Part of Site					
	By "AB" seepage from land	0.075 / 0.022	0.027	0.016	**2.8** / 0.81	**4.7 / 1.4**
	Main Canal -- upstream (25)	0.071 / 0.021	0.027	0.016	**2.6** / 0.78	**4.4 / 1.3**
	Mouth of Purvis Creek (28)	0.062 / 0.019	0.027	0.016	**2.3** / 0.70	**3.9 / 1.2**
	Reference Locations					
	Troup Creek	0.0038 / 0.0011	0.027	0.016	0.14 / 0.041	0.24 / .069
	Crescent River	0.0042 / 0.0013	0.027	0.016	0.16 / 0.048	0.26 / 0.081
Aroclor 1268	Southern Part of Site					
	By "AB" seepage from land	0.15 / 0.045	0.3	0.03	0.50 / 0.15	**5.0 / 1.5**
	Main Canal -- upstream (25)	0.096 / 0.029	0.3	0.03	0.32 / 0.097	**3.2** / 0.97
	Mouth of Purvis Creek (28)	0.049 / 0.015	0.3	0.03	0.16 / 0.050	**1.6** / 0.50
	Reference Locations					
	Troup Creek	0.010 / 0.0030	0.3	0.03	0.033 / 0.010	0.33 / 0.10
	Crescent River	0.014 / 0.0042	0.3	0.03	0.047 / 0.014	0.47 / 0.14
Lead	Southern Part of Site					
	By "AB" seepage from land	1.5 / 0.45	0.32	0.032	**4.7 / 1.4**	**47 / 14**
	Main Canal -- upstream (25)	0.21 / 0.063	0.32	0.032	0.66 / 0.20	**6.6 / 2.0**
	Reference Locations					
	Troup Creek	0.22 / 0.066	0.32	0.032	0.69 / 0.21	**6.9 / 2.1**
	Crescent River	0.13 / 0.039	0.32	0.032	0.41 / 0.12	**4.1 / 1.2**
		River Otter (*Lutra canadensis*)[f]				
Methyl-mercury	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.099 / 0.065	0.027	0.016	**3.7 / 2.4**	**6.2 / 4.1**
	Eastern Creek -- downstream (9)	0.10 / 0.066	0.027	0.016	**3.7 / 2.4**	**6.2 / 4.1**
	Western Creek Complex (13)	0.096 / 0.063	0.027	0.016	**3.6 / 2.3**	**6.0 / 3.9**
	Northern Part of Site					
	Near old oil-processing site (33)	0.098 / 0.065	0.027	0.016	**3.6 / 2.4**	**6.1 / 4.1**
	Reference Location					
	Troup Creek	0.0066 / 0.0044	0.027	0.016	0.24 / 0.16	0.41 / 0.28
Aroclor 1268	Southern Part of Site					
	Eastern Creek -- upstream (6)	0.19 / 0.13	0.3	0.03	0.63 / 0.43	**6.3 / 4.3**
	Eastern Creek -- downstream (9)	0.17 / 0.11	0.3	0.03	0.57 / 0.37	**5.7 / 3.7**
	Western Creek Complex (13)	0.15 / 0.099	0.3	0.03	0.50 / 0.33	**5.0 / 3.3**
	Northern Part of Site					
	Near old oil-processing site (33)	0.15 / 0.099	0.3	0.03	0.50 / 0.33	**5.0 / 3.3**
	Reference Location					
	Troup Creek	0.021 / 0.014	0.3	0.03	0.070 / 0.047	0.70 /0 .47
Lead	Southern Part of Site					
	Western Creek Complex (13)	0.14 / 0.092	0.32	0.032	0.44 / 0.29	**4.4 / 2.9**
	Northern Part of Site					
	Near old oil-processing site (33)	1.1 / 0.73	0.32	0.032	**3.4 / 2.3**	**34 / 23**
	Reference Location					
	Troup Creek	0.17 / 0.11	0.32	0.032	0.53 / 0.34	**5.3 / 3.4**

Table 16.__Continued

[a]PAHs are not addressed in this table since PAHs were almost never detected in prey of predators and, when detected, usually occurred at less than reporting limits at the reference locations. In addition, inorganic mercury is not addressed in the table because mean HQs for inorganic mercury (Table 15) are 2 to 5 orders-of-magnitude less than unity (1), and maximum HQs clearly would not exceed 1. Worksheets pertaining to this table are contained in Appendix I of Volume II of this report.

[b]Assumptions on which EEEs are based are presented in Table 13. EEE for red drum is expressed as mg/kg (wet wt).

[c]TRVs are reviewed in Table 14. TRVs for red drum is expressed as mg/kg (wet wt).

[d]HQs greater than 1 are identified in **bold print** in this table.

[e]EEEs, as well as LOAEL and NOAEL HQs, for raccoons are presented for an area-use-factor (AUF) of 1 (the values to the left of the "/" mark) and for an AUF of 0.3 (the values to the right of the "/").

[f]EEEs, as well as LOAEL and NOAEL HQs, for river otters are presented for an AUF of 1 (the values to the left of the "/" mark) and for an AUF of 0.66 (the values to the right of the "/").

Table 17.__ Frequency of occurrence of hazard quotients (HQs) greater than unity (1) for predators exposed to major chemicals of potential concern (COPC) in environmental media of estuary at LCP Site[a]

Major chemical of potential concern (COPC)[b]	Mean HQs		Maximum HQs		General characteristics of elevated HQs
	LOAEL	NOAEL	LOAEL	NOAEL	
Red Drum (*Sciaenops ocellatus*)					
Methyl-mercury	1 of 1 (100%)	1 of 1 (100%)	1 of 1 (100%)	1 of 1 (100%)	----------------------------------
Aroclor 1268	0 of 1 (0%)	1 of 1 (100%)	0 of 1 (0%)	1 of 1 (100%)	----------------------------------
Diamondback Terrapin (*Malaclemys terrapin*)					
---------- No HQs greater than 1 for any COPC at any location ----------					
Red-winged Blackbird (*Agelaius phoeniceus*)					
Inorganic mercury	0 of 1 (0%)	0 of 1 (0%)	0 of 1 (0%)	0 of 1 (0%)	----------------------------------
Methyl-mercury	0 of 1 (0%)	0 of 1 (0%)	0 of 1 (0%)	0 of 1 (0%)	----------------------------------
Aroclor 1268	0 of 1 (0%)	0 of 1 (0%)	0 of 1 (0%)	0 of 1 (0%)	----------------------------------
Lead	0 of 1 (0%)	1 of 1 (100%)	0 of 1 (0%)	1 of 1 (100%)	Mean and max. NOAEL HQs of 1.4 downstream in main canal (Stat. 26)
Clapper Rail (*Rallus longirostris*)					
Inorganic mercury	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	----------------------------------
Methyl-mercury	0 of 3 (0%)	1 of 3 (33%)	0 of 3 (0%)	1 of 3 (33%)	Only elevated HQs (mean NOAEL HQ = 1.2; max. NOAEL HQ = 1.3) by "AB" seepage from land
Aroclor 1268	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	----------------------------------
Lead	0 0f 2 (0%)	2 of 2 (100%)	1 of 2 (50%)	2 of 2 (100%)	Only substantially elevated HQs (mean NOAEL HQ = 10; max. NOAEL HQ = 12) by "AB" seepage from land; Troup Creek reference NOAEL HQs = 1.1 (mean value) and 1.5 (max. value)
Green Heron (*Butorides striatus*)					
Inorganic mercury	0 of 4 (0%)	0 of 4 (0%)	0 of 4 (0%)	0 of 4 (0%)	----------------------------------
Methyl-mercury	1 0f 4 (25%)	4 of 4 (100%)	1 0f 4 (25%)	4 of 4 (100%)	Highest mean NOAEL HQ = 2.5; highest max. NOAEL HQ = 2.8
Aroclor 1268	0 of 4 (0%)	0 of 4 (0%)	0 of 4 (0%)	0 of 4 (0%)	----------------------------------
Lead	0 of 2 (0%)	1 of 2 (50%)	1 of 2 (50%)	2 of 2 (100%)	Only substantially elevated HQs (mean NOAEL HQ = 10; max. NOAEL HQ = 27) near old oil-processing site in northern part of site (Stat. 33); Troup Creek reference NOAEL HQs = 1.2 (mean value) and 2.4 (max. value)
Marsh Rabbit (*Sylvilagus palustris*)					
Inorganic mercury	0 of 9 (0%)	0 of 9 (0%)	0 of 9 (0%)	0 of 9 (0%)	----------------------------------
Methyl-mercury	0 of 9 (0%)	0 of 9 (0%)	0 of 9 (0%)	0 of 9 (0%)	----------------------------------
Aroclor 1268	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	1 of 3 (33%)	Only elevated HQ (max. NOAEL HQ) = 1.2; downstream in main canal (Stat. 26)
Lead	4 of 9 (44%)	9 of 9 (100)	6 of 9 (67%)	9 of 9 (100%)	Only substantially elevated HQs (mean NOAEL HQ = 22; max. NOAEL HQ = 28) near old oil-processing site in northern part of site (Stat. 33); reference NOAEL HQs = 6.9 - 9.7 (mean values) and 7.8 - 13 (max. values)

Table 17.__Continued

Major chemical of potential concern (COPC)[b]	Mean HQs		Maximum HQs		General characteristics of elevated HQs
	LOAEL	NOAEL	LOAEL	NOAEL	
					Raccoon (*Procyon lotor*)[b]
Inorganic mercury	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	0 of 3 (0%)	————
Methyl-mercury	3 of 3 (100%)	3 of 3 (100%)	3 of 3 (100%)	3 of 3 (100%)	Elevated NOAEL HQs = 2.9 - 3.6 (mean values) and 3.9 - 4.7 (max. values)
Aroclor 1268	0 of 3 (0%)	3 of 3 (100%)	0 of 3 (0%)	3 of 3 (100%)	Elevated NOAEL HQs = 1.2 - 3.3 (mean values) and 1.6 - 5.0 (max. values)
Lead	1 of 2 (50%)	2 of 2 (100%)	1 of 2 (50%)	2 of 2 (100%)	Only notable elevated HQs (mean NOAEL HQ = 41; max. NOAEL HQ = 47) by "AB" seepage from land; reference NOAEL HQs = 2.9 - 5.6 (mean values) and 4.1 - 6.9 (max. values)
					River Otter (*Lutra canadensis*)[b]
Inorganic mercury	0 of 4 (0%)	0 of 4 (0%)	0 of 4 (0%)	0 of 4 (0%)	————
Methyl-mercury	4 of 4 (100%)	4 of 4 (100%)	4 of 4 (100%)	4 of 4 (100%)	Elevated NOAEL HQs = 4.3 - 4.8 (mean values) and 6.0 - 6.2 (max. values)
Aroclor 1268	0 of 4 (0%)	4 of 4 (100%)	0 of 4 (0%)	4 of 4 (100%)	Elevated NOAEL HQs = 3.1 - 4.0 (mean values) and 5.0 - 6.3 (max. values)
Lead	1 of 2 (50%)	2 of 2 (100%)	1 of 2 (50%)	2 of 2 (100%)	Only notable elevated HQs (mean NOAEL HQ = 14; max. NOAEL HQ = 34) near old oil-processing site in northern part of site; Troup Creek reference NOAEL HQs = 3.1 (mean value) and 5.3 (max. value)

[a]Information presented in this table is abstracted from Table 15 (mean HQs) and Table 16 (maximum HQs).

[b]HQs referenced in this table for raccoons and river otters are based on an area-use-factor (AUF) of 1, as is the case for other predators evaluated in the table. Alternative AUFs for raccoons (0.3) and river otters (0.66) are assessed in Tables 15 and 16.

able 18.__Estimation of concentrations of major chemicals of potential concern (COPC) in marsh surface sediment associated with hazard quotients (HQs) of unity (1) for predators of estuary at LCP Site

I. Screening Procedures for Estimating Maximum Environmentally Safe Concentrations (ESCs) of Major COPC in Surface Sediment

. Eliminate **PAHs** from consideration since PAHs were seldom detected in prey of predators (refer to text).

. Eliminate **inorganic mercury** from consideration since inorganic mercury is never associated with predator HQs > 1 (refer to Table 15).

. For **all other cases** -- estimate ESCs of each major COPC in surface sediment for each of eight evaluated predators if the **following three criteria** are met:

1. Diet of predator consists of a substantial percentage of a prey species with high fidelity to surface sediment; i, e., cordgrass or fiddler crabs (refer to Table 13), and
2. A meaningful regressional relationship can be established between concentration of major COPC in prey species and surface sediment (refer to Figures 13 - 18), and
3. Mitigating and/or confounding factors are absent (reference location with HQ < 1; ability to determine HQ for reference location).

II. Identification of Predator/COPC Combinations to be Evaluated

1. Red Drum (max. NOAEL HQs: 7.3 for methylmercury and 2.7 for Aroclor 1268; refer to Table 16)	1: Diet only 30% fiddler crabs (Table 13) 2: Regressional relationship between COPC -- methylmercury (Figure 13) and Aroclor 1268 (Figure 15) -- in fiddler crabs and surface sediment can be determined; however, relationship has little meaning since red drum are assummed to range throughout Purvis Creek system feeding on numerous "sub-populations" of fiddler crabs not assessed for uptake of COPC from sediment 3: No mitigating/confounding factors **No evaluation possible**: Screening Criteria 1 and 2 not met
2. Diamondback terrapin (max. NOAEL HQs for methylmercury, Aroclor 1268, and lead < 1; refer to Table 16)	1: Diet 90% fiddler crabs (Table 13) 2: Regressional relationship between two COPC -- methylmercury (Figure 13) and Aroclor 1268 (Figure 15) -- in fiddler crabs and surface sediment can be determined; however, a relationship for lead cannot be determined because of numerous undetected (U) and blank-contaminated (B) values for fiddler crabs (Table 6) 3: No mitigating/confounding factors **Evaluation possible for methylmercury and Aroclor 1268**
3. Red-Winged Blackbird (max. NOAEL HQs: 0.31 for methylmercury, 0.058 for Aroclor 1268, and 1.4 for lead; refer to Table 16)	1: Diet only 10% fiddler crabs (Table 13) 2: Regressional relationship between two COPC -- methylmercury (Figure 13) and Aroclor 1268 (Figure 15) -- in fiddler crabs and surface sediment can be determined; however, a relationship for lead cannot be determined because of numerous undetected (U) and blank-contaminated (B) values for fiddler crabs (Table 6) 3: Data not available for evaluation of reference locations **No evaluation possible**: Screening Criteria 1 and 3 not met for any COPC; Criterion 2 not met for lead
4. Clapper Rail (max. NOAEL HQs: 1.3 for methylmercury, 0.26 for Aroclor 1268, and 12 for lead; refer to Table 16)	1: Diet 85% fiddler crabs (Table 13) 2: Regressional relationship between two COPC -- methylmercury (Figure 13) and Aroclor 1268 (Figure 15) -- in fiddler crabs and surface sediment can be determined; however, a relationship for lead cannot be determined because of numerous undetected (U) and blank-contaminated (B) values for fiddler crabs (Table 6) 3: Max. NOAEL HQ for lead at reference location (Troup Creek) = 1.5 (Table 16) **Evaluation possible for methylmercury and Aroclor 1268**

Table 18.__Continued

	II. Identification of Predator/COPC Combinations to be Evaluated – Continued
5. Green Heron (max. NOAEL HQs: 2.8 for methylmercury, 0.28 for Aroclor 1268, and 27 for lead; refer to Table 16)	1: Diet only 5% fiddler crabs (Table 13) 2: Regressional relationship between two COPC – methylmercury (Figure 13) and Aroclor 1268 (Figure 15) – in fiddler crabs and surface sediment can be determined; however, a relationship for lead cannot be determined because of numerous undetected (U) and blank-contaminated (B) values for fiddler crabs (Table 6) 3: Max. NOAEL HQ for lead at reference location (Troup Creek) = 2.4 (Table 16) **No evaluation possible**: Screening Criterion 1 not met for any COPC; Criteria 2 and 3 not met for lead
6. Marsh rabbitt (max. NOAEL HQs: 0.054 for methylmercury, 1.2 for Aroclor 1268, and 28 for lead; refer to Table 16)	1: Diet 100% cordgrass (Table 13) 2: Regressional relationship between two COPC – inorganic mercury (Figure 16) and lead (Figure 18) – in cordgrass and surface sediment is not well defined; a relationship for Aroclor 1268 cannot be determined because of numerous undetected (U) values for cordgrass (Table 6) 3: Max. NOAEL HQ for lead at reference location (Crescent River) = 13 (Table 16) **No evaluation possible**: Screeing Criterion 2 not met for any COPC; Criterion 3 not met for lead
7. Raccoon (max. NOAEL HQs: 4.7 for methylmercury, 5.0 for Aroclor 1268, and 47 for lead; refer to Table 16; AUF = 1)	1: Diet 45% fiddler crabs (Table 13) 2: Regressional relationship between two COPC – methylmercury (Figure 13) and Aroclor 1268 (Figure 15) – in fiddler crabs and surface sediment can be determined; however, a relationship for lead cannot be determined because of numerous undetected (U) and blank-contaminated (B) values for fiddler crabs (Table 6) 3: Max. NOAEL HQ for lead at reference location (Troup Creek) = 6.9 (Table 16) **Evaluation possible for methylmercury and Aroclor 1268**
8. River otter (max. NOAEL HQs: 6.2 for methylmercury, 6.3 for Aroclor 1268, and 34 for lead; refer to Table 16; AUF = 1)	1: Diet only 10% fiddler crabs (Table 13) 2: Regressional relationship between two COPC – methylmercury (Figure 13) and Aroclor 1268 (Figure 15) – in fiddler crabs and surface sediment can be determined; however, a relationship for lead cannot be determined because of numerous undetected (U) and blank-contaminated (B) values for fiddler crabs (Table 6) 3: Max. NOAEL HQ for lead at reference location (Troup Creek) = 5.3 (Table 16) **No evaluation possible**: Screening Criterion 1 not met for any COPC; Criteria 2 and 3 not met for lead

III. Evaluation of all Possible Predator/COPC Combinations

Basic Procedures

1. Assume that the dominant prey species (fiddler crabs in all cases) constitutes 100% of predator's diet.
2. Assume that diet (prey species) constitutes the sole source of all COPC (i. e., methylmercury and Aroclor 1268) for predators. (Contributions from surface sediment and water are negligable.)
3. Back-calculate the concentration of COPC in prey species associated with a HQ of 1 by the following equation:

$$C_{(HQ=1)} = \frac{(TRV)\,(BW)}{FR},$$

with $C_{(HQ=1)}$ = concentration of COPC in prey for a HQ of 1 (mg/kg, dry wt), TRV = LOAEL or NOAEL toxicity reference value for predator (mg/kg BW/day), BW = body weight of predator (kg, wet wt), and FR = food ingestion rate of predator (kg/day, dry wt).

4. Estimate the concentration of COPC in surface sediment (mg/kg, dry wt) that is associated with $C_{(HQ=1)}$ by solving for "x" in the regression equations presented in Figure 13 (methylmercury) and Figure 15 (Aroclor 1268).

Table 18.__Continued

III. Evaluation of all Possible Predator/COPC Combinations – Continued

Results

Methylmercury Evaluation

Predator evaluated	Concentration of methylmercury in surface sediment (mg/kg, dry wt) associated with $C_{(HQ=1)}$[a]			
	LOAEL-related values		NOAEL-related values	
	Linear equation	Exponential equation	Linear equation	Exponential equation
Diamondback terrapin	13.0481	0.0104	1.3046	0.0083
	Geometric mean: 0.37		Geometric mean: 0.10	
Clapper rail	0.0094	0.0037	0.0046	0.0030
	Geometric mean: 0.0059		Geometric mean: 0.0037	
Raccoon	0.0053	0.0031	0.0030	0.0026
	Geometric mean: 0.0041		Geometric mean: 0.0028	

Aroclor 1268 Evaluation

Predator evaluated	Concentration of Aroclor 1268 in surface sediment (mg/kg, dry wt) associated with $C_{(HQ=1)}$[b]			
	LOAEL-related values		NOAEL-related values	
	Linear equation	Exponential equation	Linear equation	Exponential equation
Diamondback terrapin	270	1.8	27	1.3
	Geometric mean: 22		Geometric mean: 5.9	
Clapper rail	51	1.5	5.1	1.0
	Geometric mean: 8.7		Geometric mean: 2.3	
Raccoon	1.9	0.83	0.20	0.38
	Geometric mean: 1.26		Geometric mean: 0.28	

[a]All tabulated concentrations of methylmercury in surface sediment were obtained by extrapolation of regression equations (Figure 13) beyond the limits of observed data.

[b]Most tabulated concentrations of Aroclor 1268 in surface sediment were obtained by extrapolation of regression equations (Figure 15) beyond the limits of observed data. The only exceptions are both NOAEL-related values for the raccoon.

6.2.2 Clapper Rail

The same regressional relationships between concentrations of COPC in fiddler crabs and surface sediment, as described above for diamondback terrapins (e.g., Figures 13 and 15) also pertain to clapper rails.

In the case of clapper rails exposed to methylmercury, the best estimate of a LOAEL-related ESC in surface sediment is believed to be 0.0059 mg/kg (dry wt), while a NOAEL-related ESC is estimated as 0.0037 mg/kg (Table 18). For Aroclor 1268, the best estimate of a LOAEL-related ESC in surface sediment is believed to be 8.7 mg/kg (dry wt), while a NOAEL-related ESC is estimated as 2.3 mg/kg.

6.2.3 Marsh Rabbit

Although marsh rabbits were a candidate for estimating ESCs of COPC in surface sediment, they were eliminated from the exercise because reliable regressional relationships surprisingly could not be identified for COPC in cordgrass (the sole food of rabbits) and surface soil. For methylmercury (Figure 16), r^2 ranged from just 0.15 to 0.22, while for lead, r^2 was 0.04 (Figure 18). (The relationship for total mercury is presented in Table 17 just for general interest.) A reliable regressional relationship could not be documented for Aroclor 1268 because of numerous undetected values of Aroclor 1268 in cordgrass (Table 6).

6.2.4 Raccoon

The same regressional relationships between concentrations of COPC in fiddler crabs and surface sediment, as described above for diamondback terrapins and clapper rails (e.g., Figures 13 and 15) also pertain to raccoons.

The raccoon generated the most conservative (lowest) ESCs of both methylmercury and Aroclor 1268 in marsh surface sediment. In both cases, an AUF of 1 was assumed. For methylmercury, ESCs in sediment are estimated as 0.0041 mg/kg (dry wt) for LOAEL protection and 0.0028 mg/kg for NOAEL protection. For Aroclor 1268, estimated ESCs are 1.26 mg/kg (dry wt) for LOAEL protection and 0.28 mg/kg for NOAEL protection.

Comparison of the above-estimated ESCs of sedimentary methylmercury to methylmercury measured in surface sediment at 25 evaluated marsh sampling stations at the LCP Site (Table 5) identifies only 6 of the stations (24%) that pose no ecological risk as determined by NOAEL-associated standards, and only 8 of the stations (32%) that pose no risk according to LOAEL-related standards. For Aroclor 1268, only 6 of the stations (24%) reflect NOAEL-related standards, but 16 stations (64%) reflect LOAEL-related standards.

If it is assumed that the regressional relationships developed for methylmercury and Aroclor 1268 in fiddler crabs vs. marsh sediment can be projected to creek sediment, the latter type of sediment can be evaluated for ESCs of chemicals. For creek sediment and methylmercury, 21 of 32 sampling stations at the site (66%) pose no ecological risk as determined by NOAEL-associated standards, and 26 of the stations (81%) pose no risk according to LOAEL-related standards. For Aroclor 1268, only 8 of the stations (25%) reflect NOAEL-related standards, but 19 stations (59%) reflect LOAEL-related standards.

6.3 Uncertainty Analysis

Major potential sources of uncertainty in the BERA for the LCP Site are the conceptual model for the investigation, the experimental design of the investigation, and the modeling studies conducted as part of the investigation.

6.3.1 Conceptual Model for Investigation

The conceptual model for the BERA is believed to be characterized by minimal uncertainty. The estuary at the LCP Site has been the subject of numerous previous investigations. COPC are well known, as are exposure pathways, and biota at potential risk. The eight assessment endpoints comprehensively address the various taxonomic and trophic categories of biota that are indigenous to the estuary. Measurement endpoints employed to evaluate the assessment endpoints include, whenever possible, a combination of field, laboratory, and modeling studies. The conceptual model for the BERA is the product of numerous detailed discussions among many private and government scientists.

6.3.2 Experimental Design of Investigation

Implementation of the experimental design of the BERA introduced a number of mostly unavoidable uncertainties. The most basic uncertainty is the extent to which sampling data can be extrapolated to the overall estuary since all sampling was authoritative in character and, therefore, lacked a random component. Limited sample size and resulting limited precision of data was also problematic, particularly with regard to the number of sampling stations at which prey species were collected. This limitation resulted in regressional relationships between concentrations of COPC in prey vs. surface sediment to be predicated on just a few paired data points. In addition, the small number of sediment samples evaluated for toxicity (particularly amphipod toxicity) limited the ability to identify correlations between sediment chemistry and toxicity. The benthic macroinvertebrate study had an uncertain meaning.

6.3.3 Modeling Studies in Investigation

The preponderance of uncertainty in this BERA is associated with modeling studies. In initial HQ development, obvious uncertainties pertain to selection of various exposure-related statistics (in particular, composition of predator diet and food ingestion rate) and selection of both LOAEL and NOAEL TRVs. An uncertainty of particular importance is the common use of TRVs derived from studies of Aroclor 1254 rather than the probably less toxic, site-associated Aroclor 1268.

A "hidden" uncertainty is the need to sometimes employ, in the same food-web model, prey species collected at near-by, but different, sampling stations when, in a multi-prey diet, not all prey occurred at the same sampling station. Indeed, in some cases, the total absence of a prey species for an area (i. e., insects at both reference locations; silver perch at the Crescent River reference location) precluded the development of some HQs for the area (in these cases, HQs for, respectively, the red-winged blackbird and river otter). In another case (the clapper rail model), the absence of insects at the reference locations forced a change in diet composition to a greater percentage of mummichogs. A similar uncertainty is unique to the red drum models, in which concentrations of COPC in prey collected at different sampling stations, not all of which are ideal habitat for red fish, are projected to Purvis Creek.

Substantial uncertainty is inherent in the estimation of ESCs of methylmercury and Aroclor 1268 in surface sediment by "back-calculation" of HQs derived in food-web models for selected predators – i. e., diamondback terrapin, clapper rail, and raccoon. The sources of this uncertainty are: 1) the use of simplistic exposure assumptions (i. e., that the dominant prey species – fiddler crabs in all cases – constitutes 100% of the predator's diet; also, uptake of COPC from surface sediment and surface water are negligible and, therefore, discounted); 2) use of regression equations characterized by coefficients of determination (r^2) of less than 1 for relating body burdens of COPC in fiddler crabs to concentrations in surface sediment; 3) frequent extrapolation of regression equations beyond the limits of observed data to identify ESCs of COPC in surface sediment; 4) extrapolation of ESCs of COPC in marsh surface sediment to creek surface sediment, and 5) inability to define a reliable relationship between concentrations of methylmercury and total mercury in surface sediment and, consequently, inability to estimate an ESC of the commonly measured form of mercury.

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All data analysis and report writing was performed by Dr. Rose with the exception of material pertaining to fish modeling and preliminary screening of chemicals of potential concern. Dr Saranko directed these two activities.

FIGURES

Figure 1.__ Location of LCP Site in Brunswick, Georgia

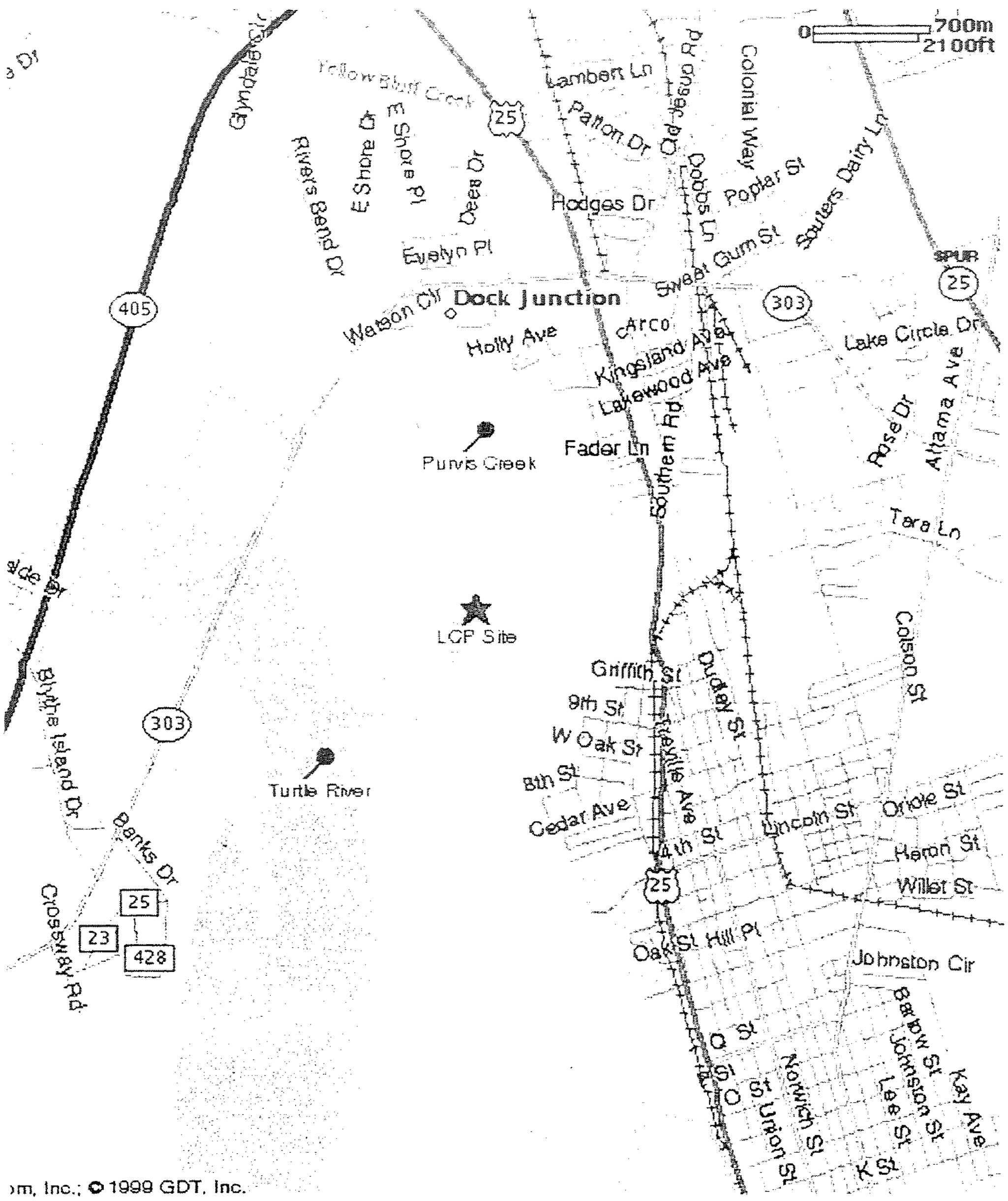

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Figure 4._Locations of sampling stations for marsh surface sediment of estuary at LCP site

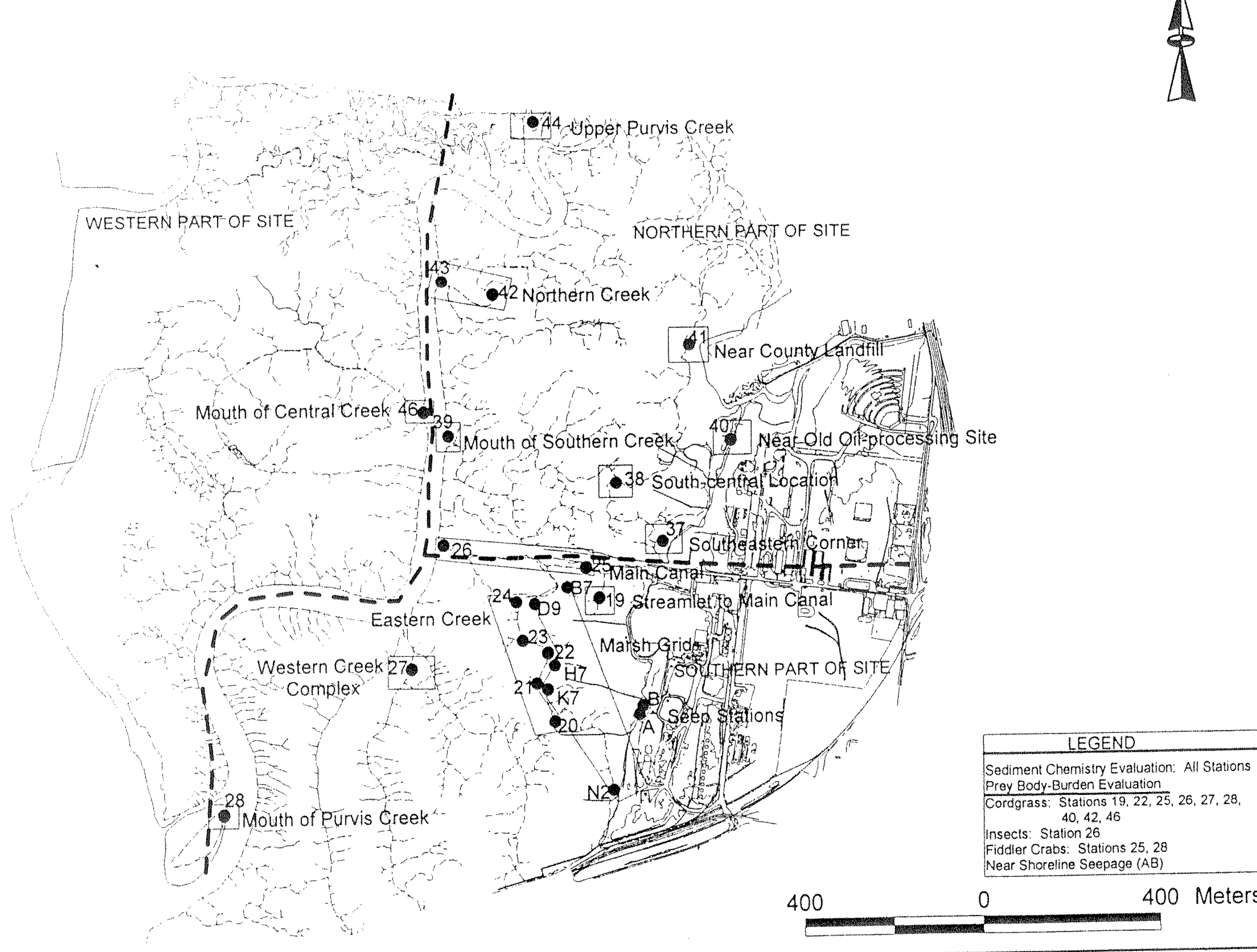

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Figure 5.__Relationships between total mercury and methylmercury concentrations in creek surface water of estuary at LCP Site

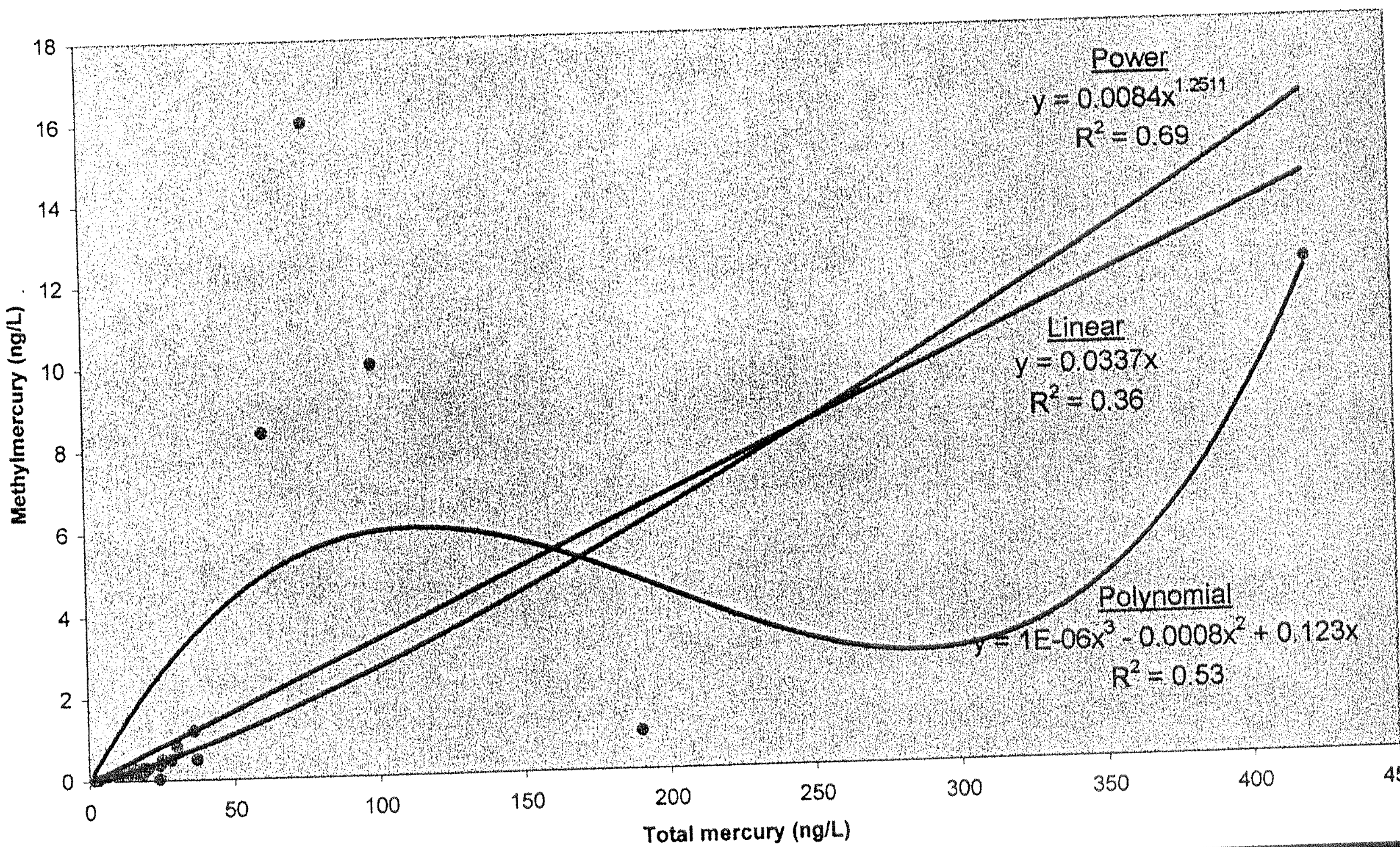


Figure 6__ Total mercury concentrations in creek surface and subsurface waters during a tidal cycle at mouth of main canal (Sampling Station 5) in estuary at LCP Site. Hours reflect ebb tide (Hours 1-4 and 11-12) and flood tide (Hours 5-10).

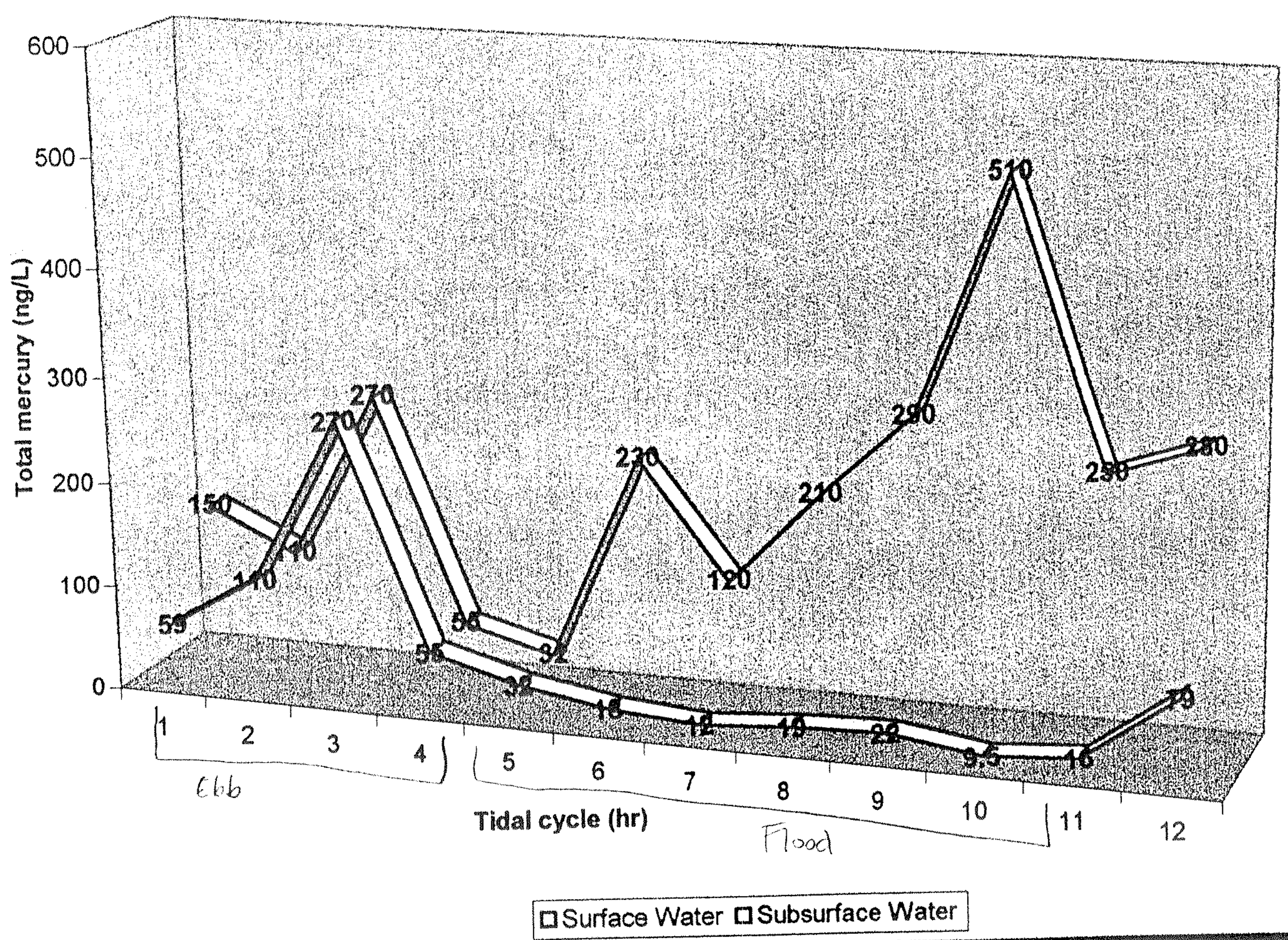


Figure 7.__Suspended particulate matter in creek surface and subsurface waters during a tidal cycle at mouth of main canal (Sampling Station 5) in estuary at LCP Site. Hours reflect ebb tide (Hours 1-4 and 11-12) and flood tide (Hours 5-10).

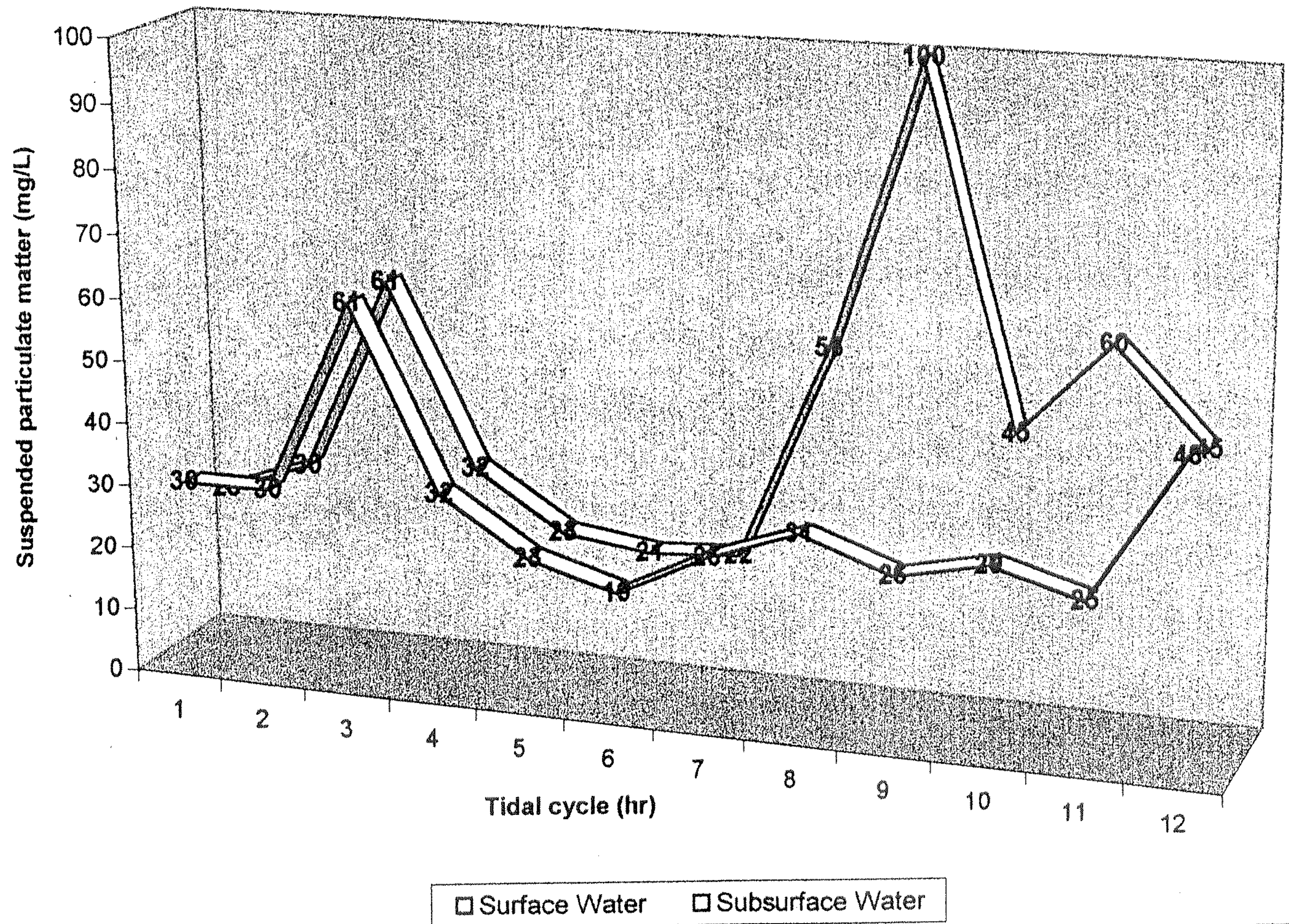


Figure 8.__Relationships between total mercury and methylmercury concentrations in creek surface sediment of estuary at LCP Site

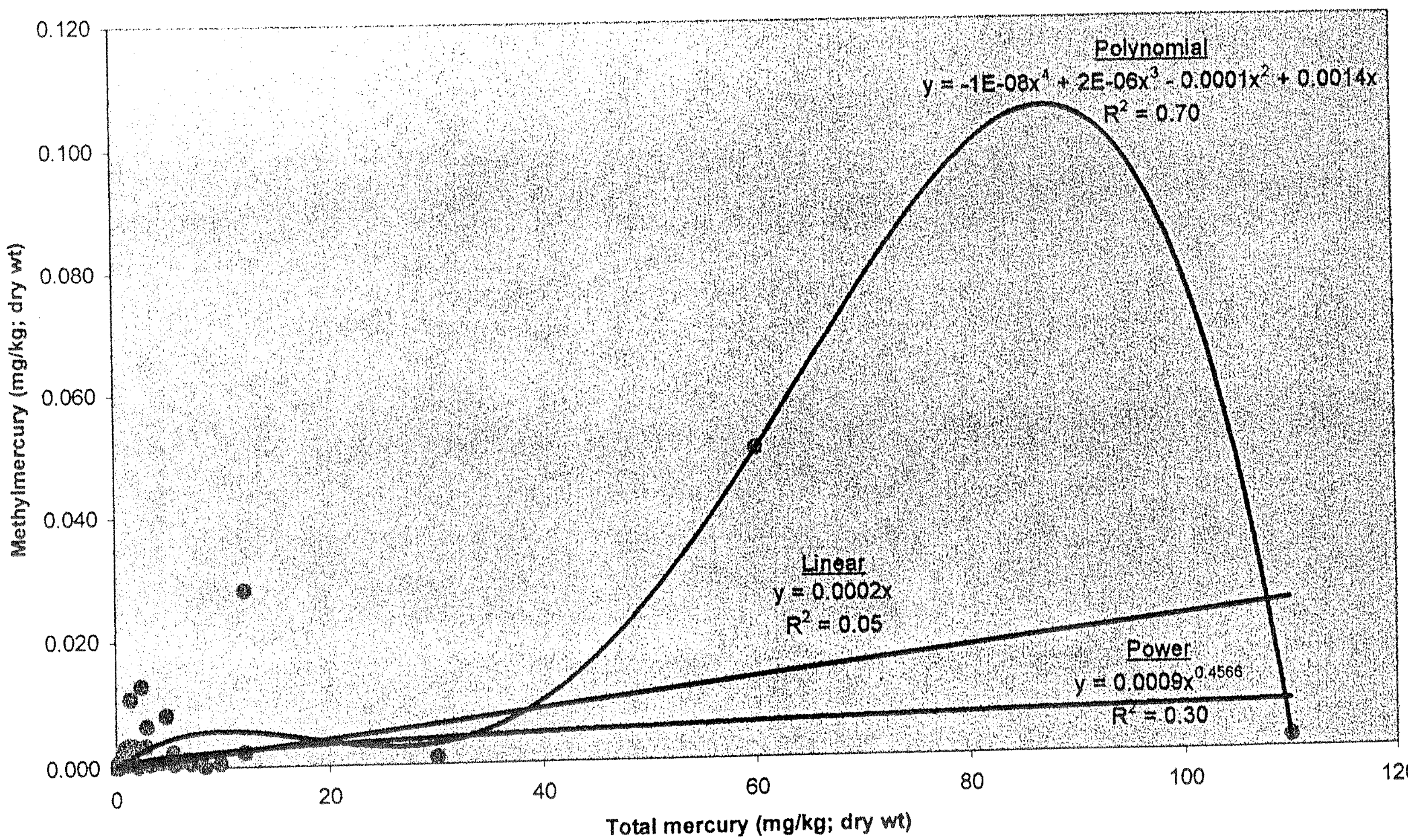


Figure 9.__Relationships between total mercury and Aroclor 1268 concentrations in creek surface sediment of estuary at LCP Site

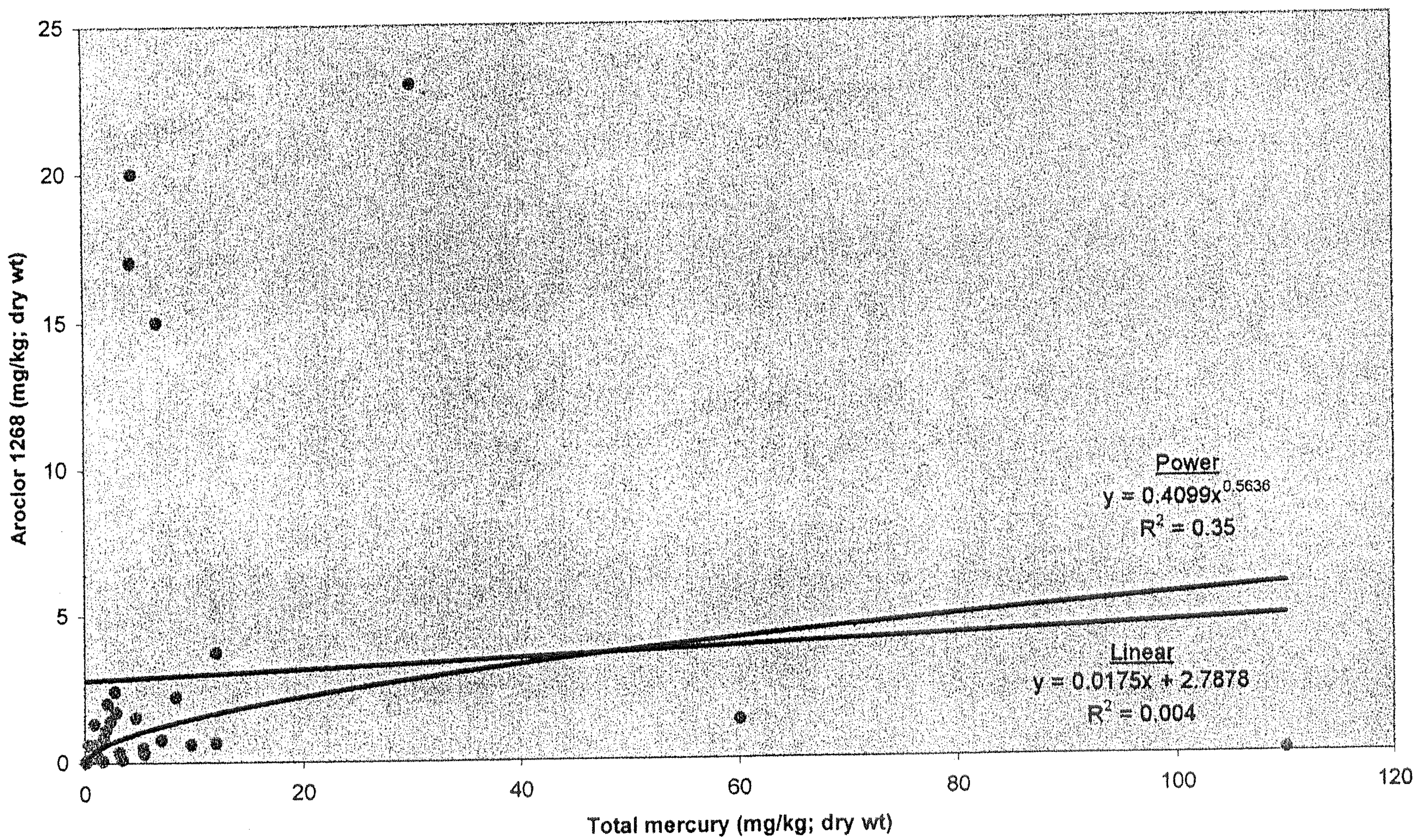


Figure 10.__Schematic illustration of total mercury and Aroclor 1268 concentrations in creek surface sediment along transects at selected sampling stations in estuary at LCP Site. Sediment was sampled down to a depth of about 15 cm. All measurements are in mg/kg or ppm dry wt.

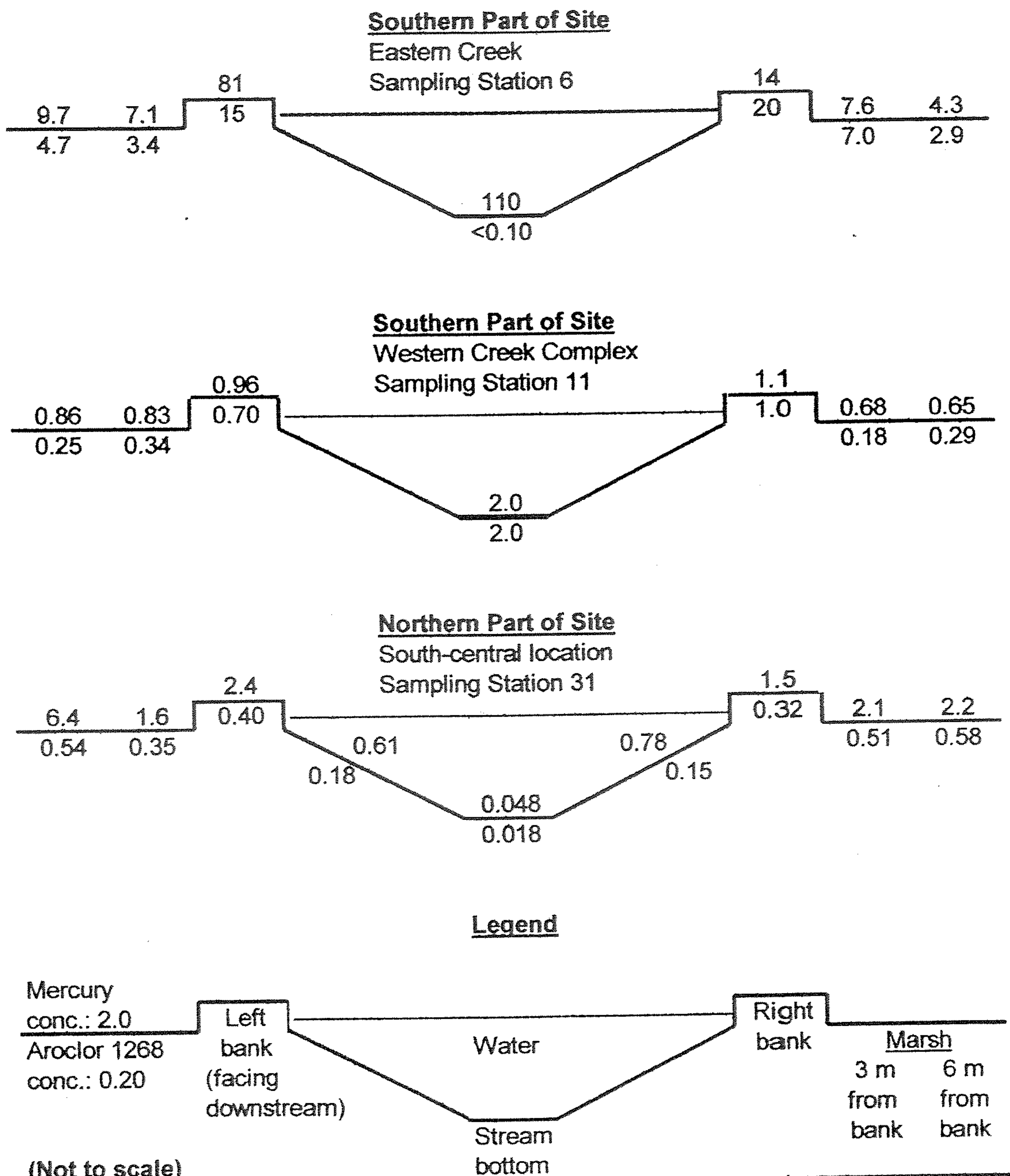


Figure 11.__Relationships between total mercury and methylmercury concentrations in marsh surface sediment of estuary at LCP Site

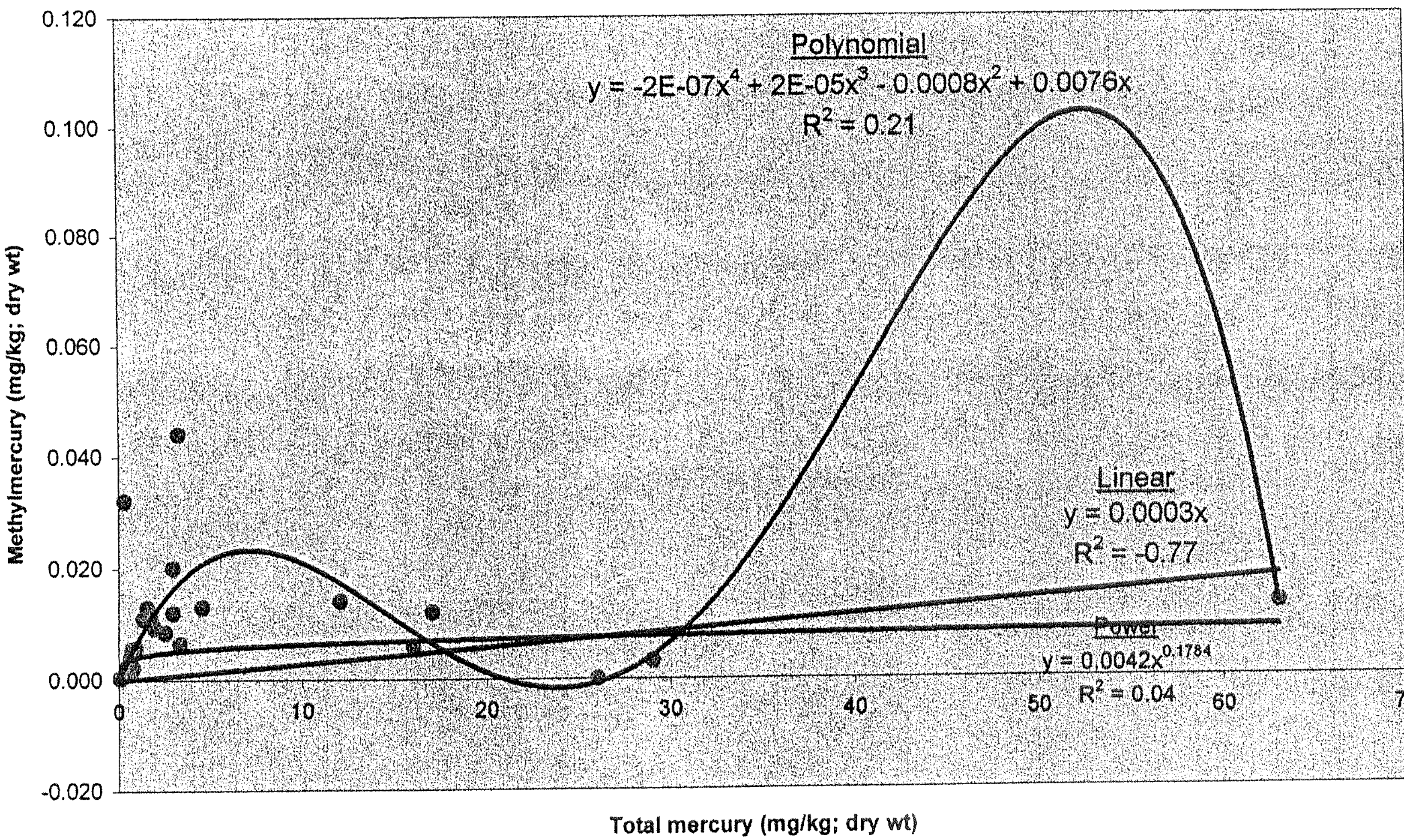


Figure 12.__Relationships between total mercury and Aroclor 1268 concentrations in marsh surface sediment of estuary at LCP Site

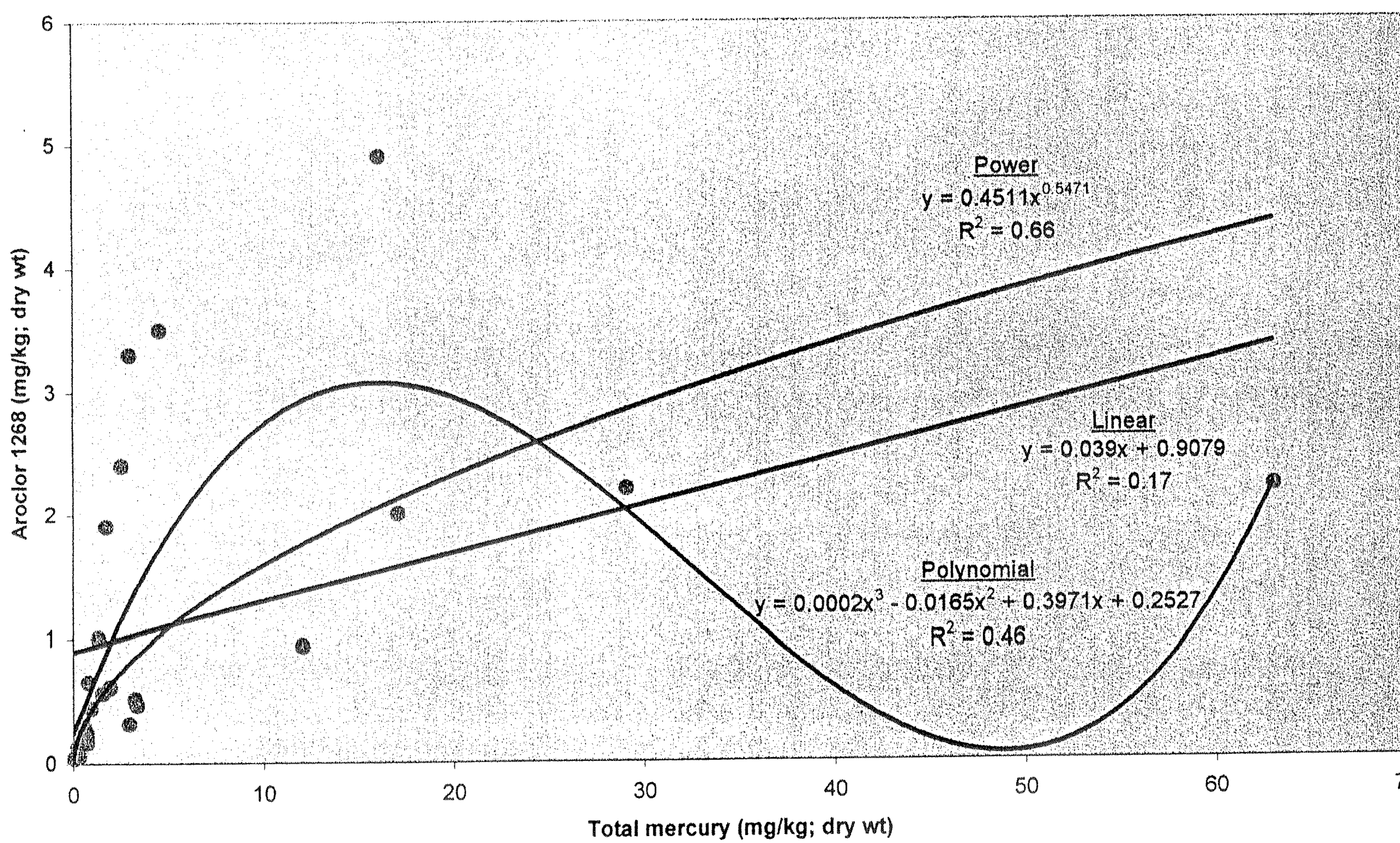


Figure 13.__Relationships between mean methylmercury concentrations in marsh surface sediment and whole bodies of fiddler crabs (Uca spp.) of estuary at LCP Site

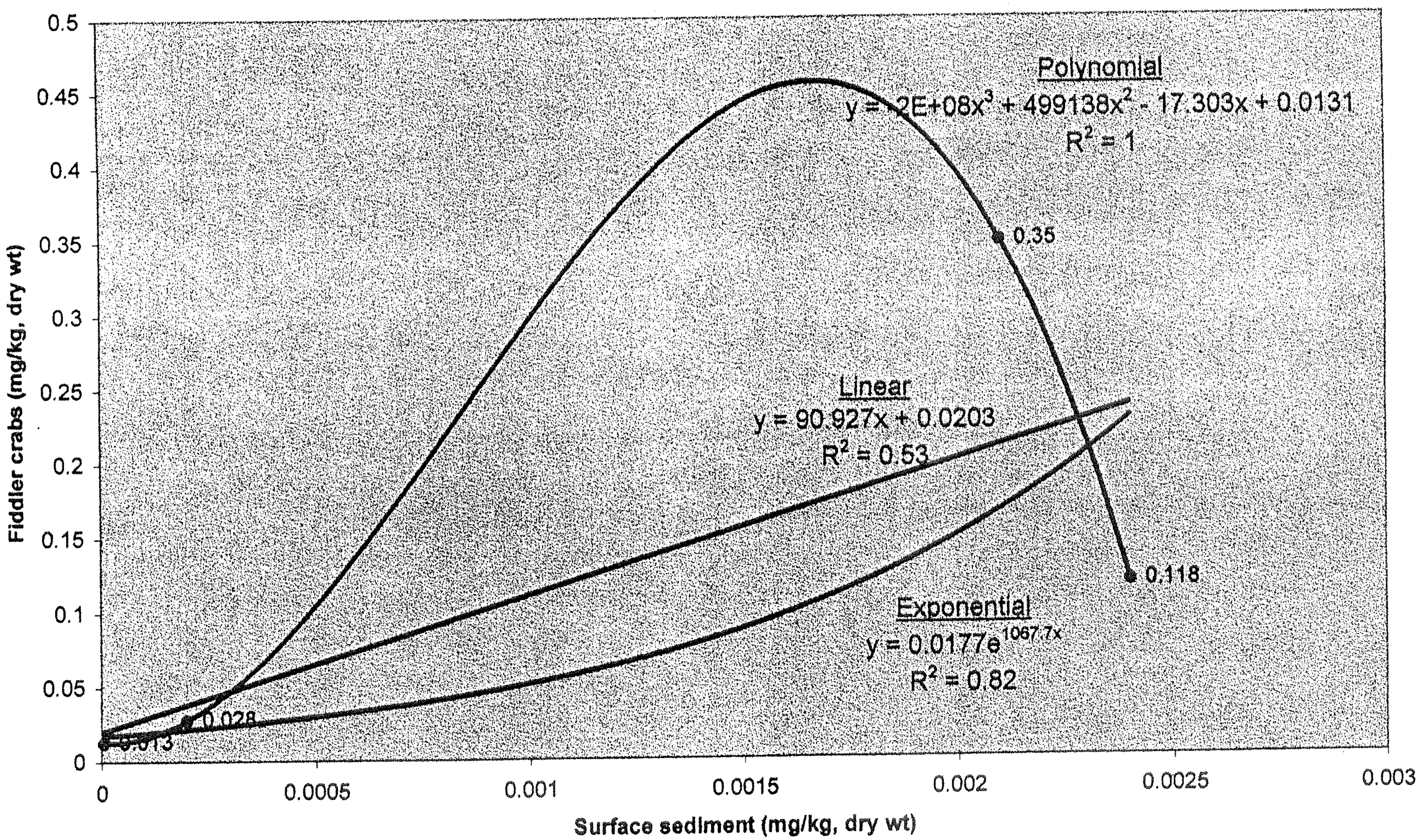


Figure 14.__Relationships between mean total mercury concentrations in marsh surface sediment and whole bodies of fiddler crabs (Uca spp.) of estuary at LCP Site

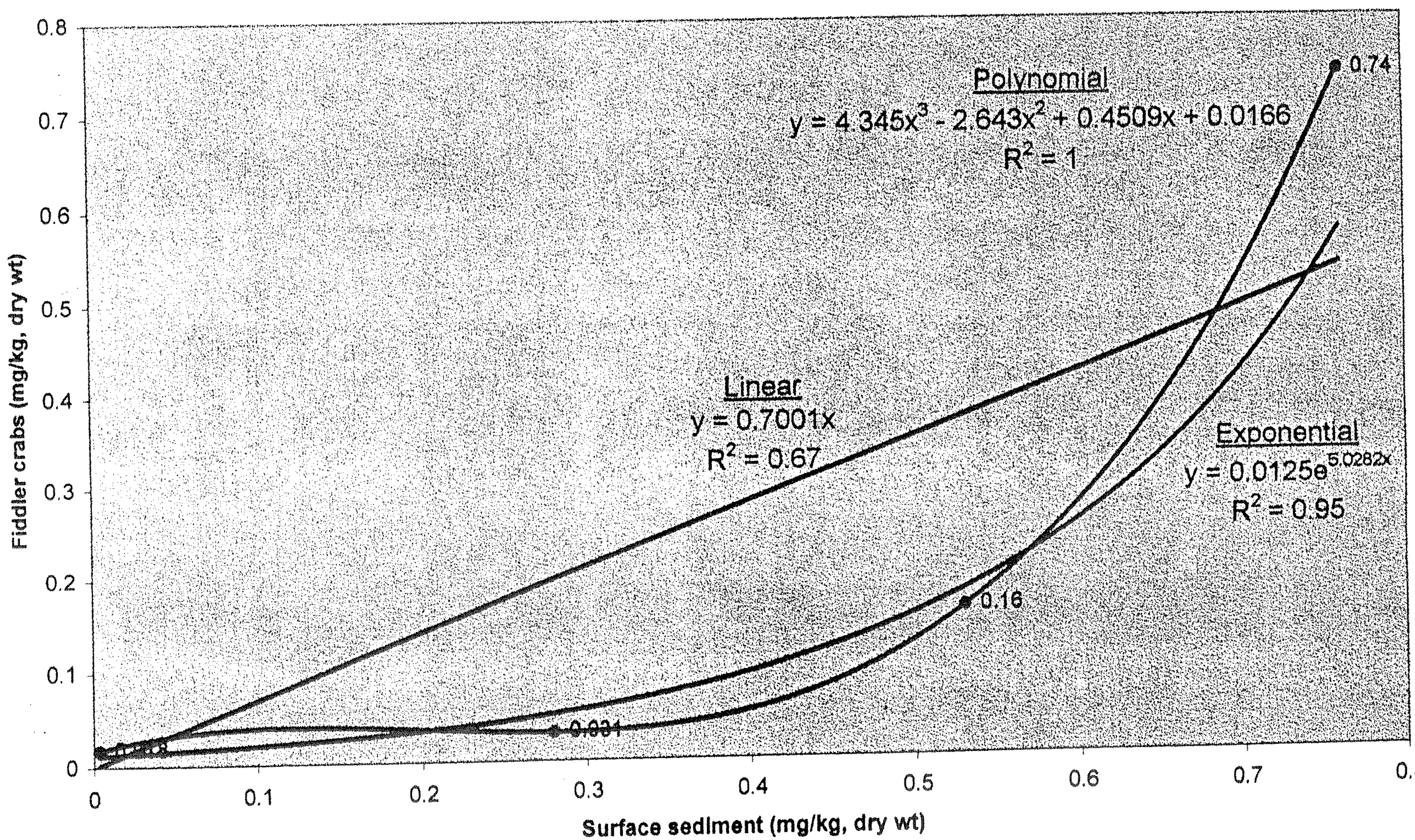


Figure 15.__Relationships between mean Aroclor 1268 concentrations in marsh surface sediment and whole bodies of fiddler crabs (Uca spp.) of estuary at LCP Site

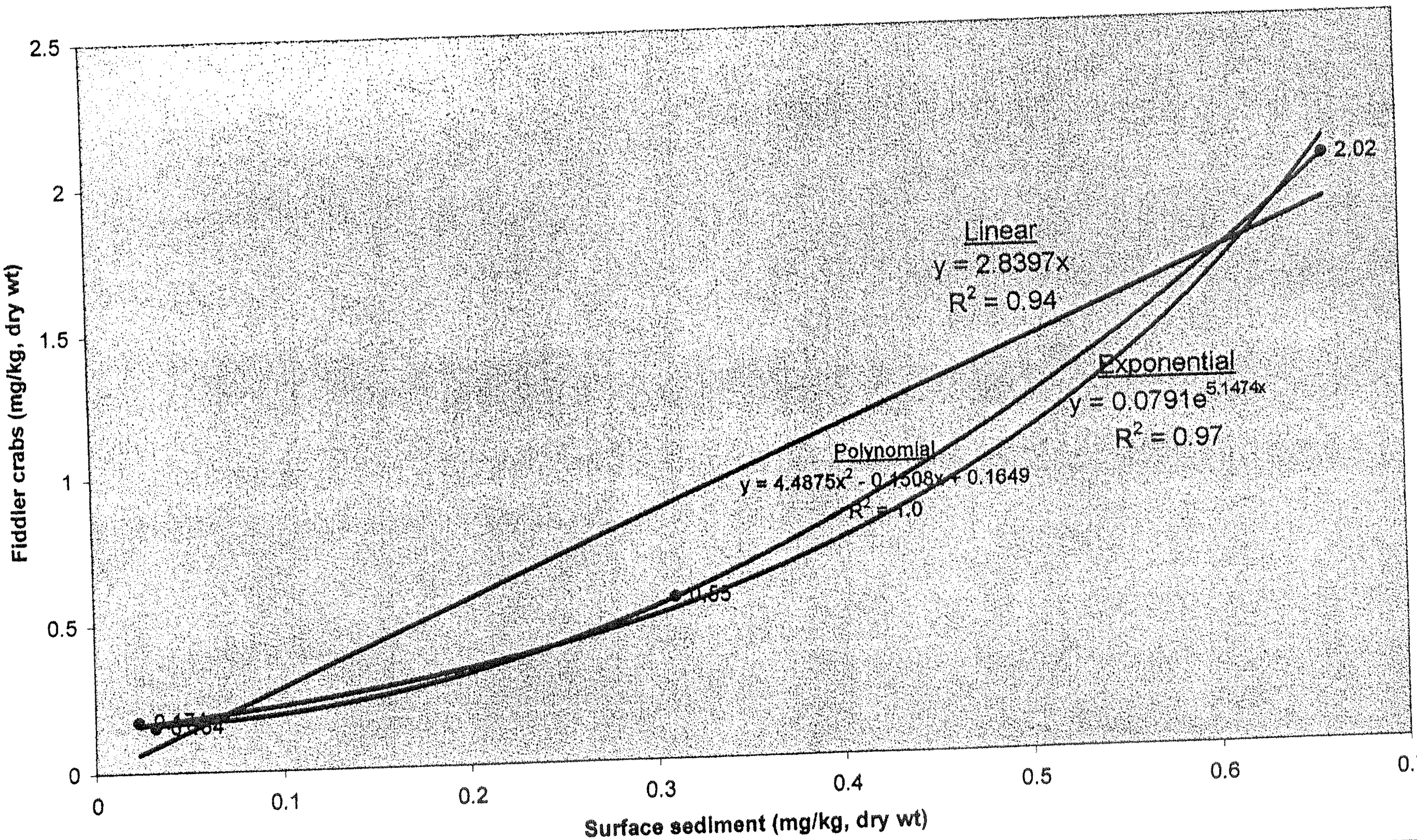


Figure 16.__ Relationships between mean methylmercury concentrations in marsh surface sediment and cordgrass (Spartina alterniflora) of estuary at LCP Site

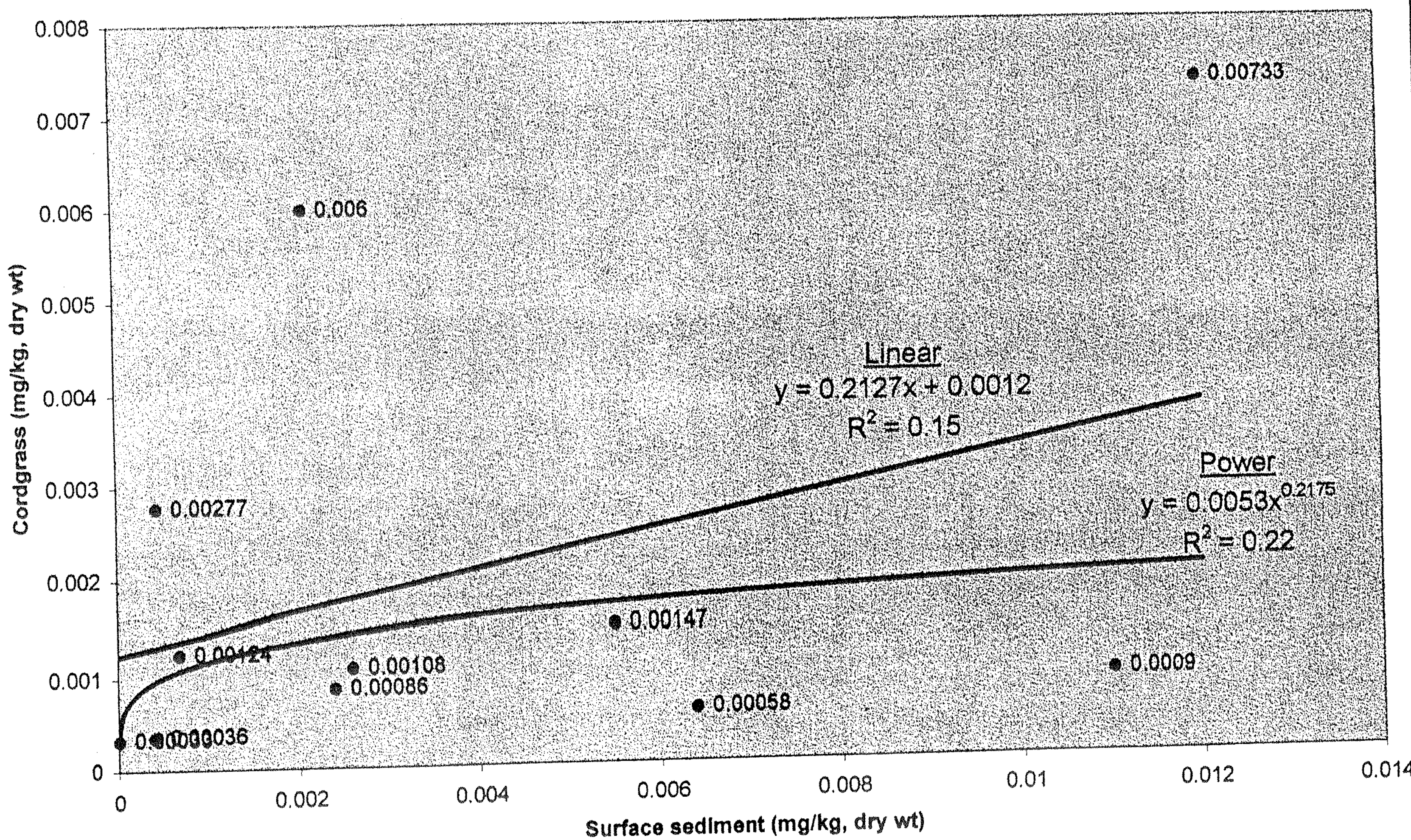


Figure 17.__ Relationships between mean total mercury concentrations in marsh surface sediment and cordgrass (Spartina alterniflora) of estuary at LCP Site

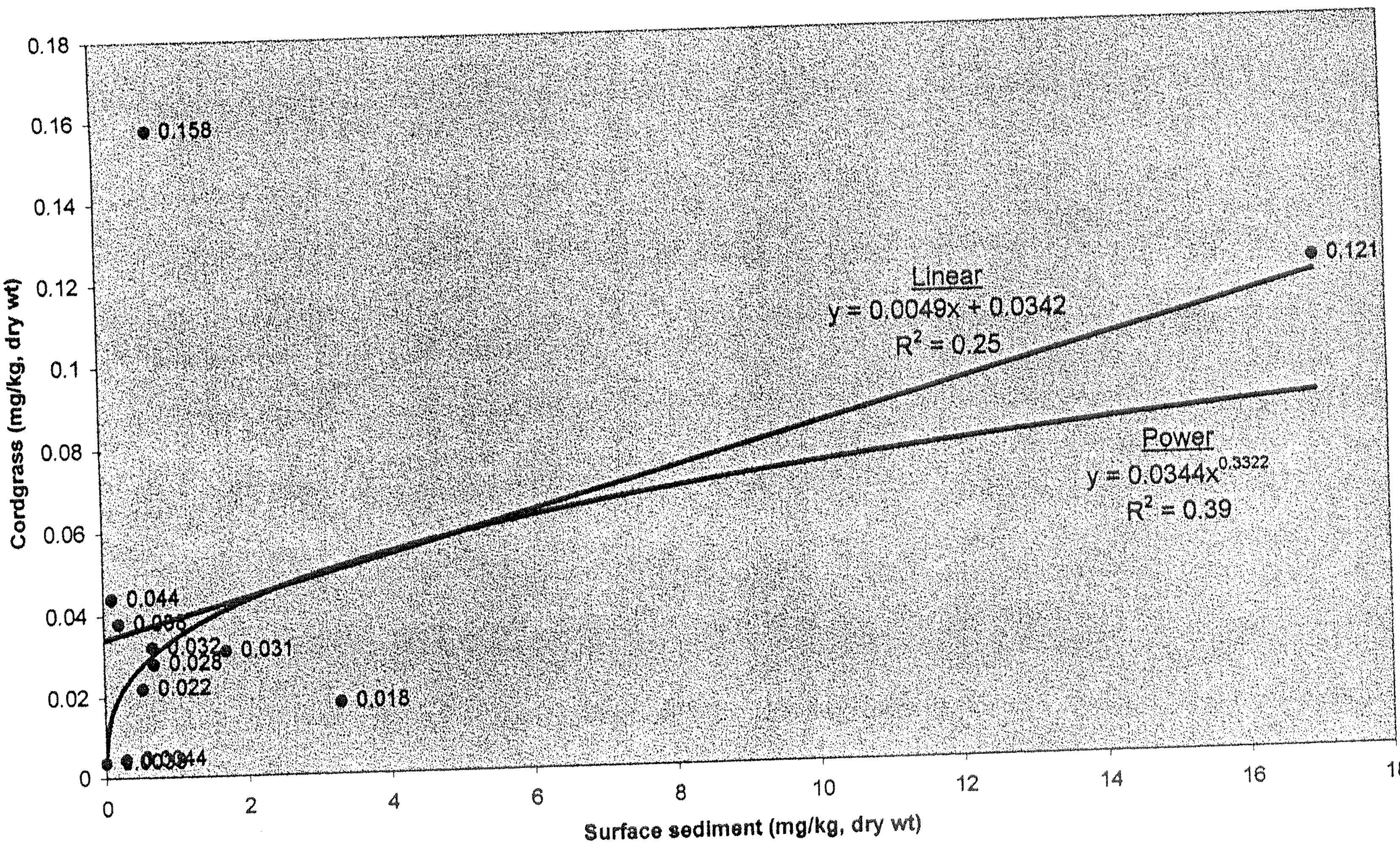
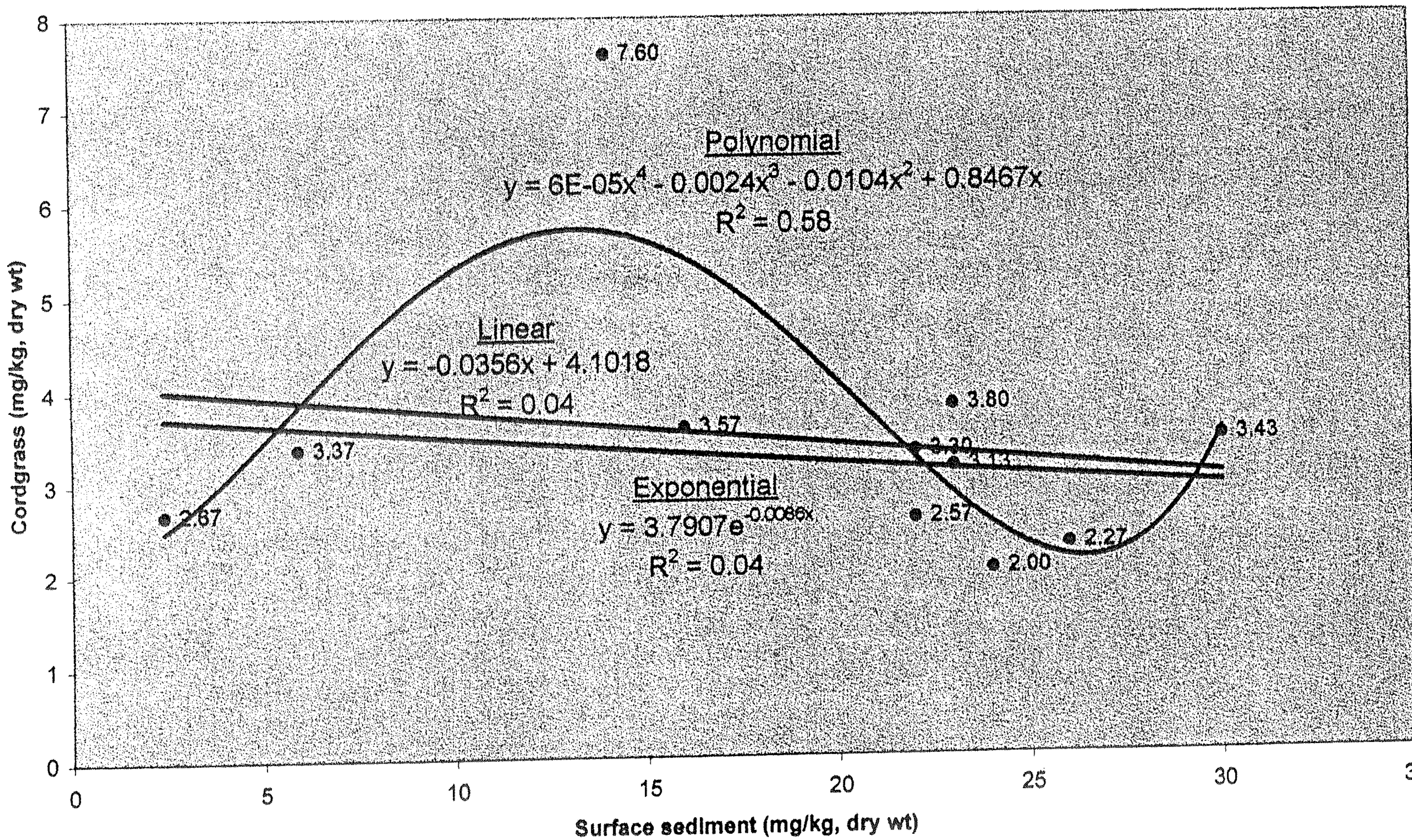


Figure 18.__Relationships between mean lead concentrations in marsh surface sediment and cordgrass (Spartina alterniflora) of estuary at LCP Site



TABLES

Table 1.__Basic experimental design for data generation and analysis in investigation of estuary at LCP Site[a]

Measurement[b]	Number of sampling stations[c]	Analytical method[d]	Typical reporting limit	Other details
		Surface Water Chemistry (Creek Water)		
General water quality characteristics	Variable	—	—	—
Mercury	29	Specialty	0.15 ng/L	Sampling performed by "clean-hands" technique;
Methylmercury	29	CVAFS	0.025 ng/L	analyses performed by Frontier GeoSciences
Aroclor 1268	29	8082	1.0 ug/L	—
Lead	29	6010	5.0 ug/L	Total lead always eval.; diss. lead sometimes eval.
PAHs	29	8270	0.20 ug/L	18 different PAHs evaluated
		Surface Water Toxicity (Creek Water)		
Mysids	6	1007	—	Chronic toxicity evaluation
Sheepshead minnows	6	1004	—	Chronic toxicity evaluation
		Surface Sediment Chemistry (Creek and Marsh Sediment)[e, f]		
Grain-size distribution	53	ASTM D422	—	% silt and clay addressed in main report
Total organic carbon	53	9060	<0.26%	—
Mercury	53	Specialty	<0.0032 mg/kg	Analyses performed by
Methylmercury	53	CVAFS	<0.000010 mg/kg	Frontier GeoSciences
Aroclor 1268	53	8082	0.10 mg/kg	—
Lead	53	6010	<2.0 mg/kg	—
PAHs	53	8270	0.025 mg/kg	18 different PAHs evaluated
		Surface Sediment Toxicity (Creek Sediment)[e]		
Amphipods	6	CBP/TRS 89/93	—	28-day chronic test; 5 replicates per sampling station
Grass shrimp	11	Lee test	—	2-month chronic test; 3 replicates per sampling station
		Surface Sediment Biota (Creek Sediment)[e]		
Benthic macroinvertebrate community	6	—	—	Numerical evaluation; 3 replicates per sampling station
		Chemical Body Burdens of Biota – Whole Bodies (Creek and Marsh Stations)[f]		
Cordgrass	11	—	—	3 replicates per sampling station; each replicate = ~ 200 g of plants collected from ~ 2 to 15 cm from ground; samples rinsed with ambient water in field and distilled water 2X in lab
Fiddler crabs	5	—	—	4 to 7 replicates of 8 - 20 composited male crabs per sampling station; replicate weight = 30 - 63 g; mixed species except mostly red-jointed fiddlers at Troup Creek and Crescent River; and mud crabs at Stat. 25, Replicate 2
Insects	1	—	—	1 sample (11 g) of combined grasshoppers, butterflies, and moths from Stat. 26
Mummichogs	6	—	—	3 replicates of 7 - 20 composited fish per sampling station; replicate weight = 23 - 77 g
Blue crabs	4	—	—	7 replicates of individual male crabs per sampling station; crab length (point-to-point on carapace) = 70 - 175 mm (32 - 323 g); crabs from Troup Creek and Crescent River smaller than crabs from site
Silver perch[g]	2	—	—	8 replicates of individual silver perch per sampling station; fish length (total length) = 113 - 195 mm (14 - 106 g); fish from Troup Creek smaller than fish from site

Table 1.__Continued

Measurement[b]	Number of sampling stations[c]	Analytical method[d]	Typical reporting limit	Other details
Chemical analyses performed on whole bodies of biota				
Lipid content (just crabs and fish)		OB 10/90	—	—
Mercury	—	Specialty	<0.00031 mg/kg	Analyses performed by
Methylmercury	—	CVAFS	<0.000047 mg/kg	Frontier GeoSciences
Aroclor 1268	—	8082	0.45 mg/kg	—
Lead	—	6010	2.0 mg/kg	—
PAHs	—	8270	~ 10 mg/kg	17 different PAHs evaluated

[a]Basic experimental design reflects initial objectives of the investigation and actual accomplishments.

[b]Measurements addressed in this table (and associated text) pertain to just major chemicals of potential concern (COPC) and related variables. Numerous other chemicals were evaluated during the investigation and are addressed in Vol. II of this report.

[c]Number of sampling stations include two reference locations – Troup Creek and the Crescent River.

[d]Analytical methods are USEPA methods unless otherwise indicated.

[e]Surface sediment is defined as between 0 and 15 cm in depth.

[f]Typical reporting limits for chemicals in surface sediment and biota are expressed in terms of, respectively, dry weight and wet weight.

[g]Several other fishes were collected during the investigation in addition to silver perch. A spot (148 mm in total length; 35 g) was collected from the Crescent River. A spotted seatrout (230 mm and 111g), as well as two black drum (215 mm /172 g; 230 mm / 208 g), were captured at the site (Purvus Creek).

Table 2.__Representative general water quality characteristics of creek surface water of estuary at LCP Site[a]

Sampling station	Temperature (°C)	Salinity (ppt)	pH (pH units)	Dissolved oxygen (mg/L)	Conductivity (mS/cm)
		Southern Part of Site			
Main Canal (upstream to downstream)					
1	--	29.9	--	--	46.0
2	--	29.9	--	--	34.4
3	--	--	--	--	--
4	22.4	29.5	--	5.9	43.2
5 (Sample 1)	19.6	29.6	--	4.0	45.7
Eastern Creek (upstream to downstream)					
6	22.3	2.6 (?)	7.2	7.4	39.8
7	23.0	2.5 (?)	7.7	--	38.8
8	20.4	2.6 (?)	7.3	--	40.9
9	--	29.5	--	--	41.6
Western Creek Complex (upstream to downstream)					
10	22.5	13.1	--	5.2	20.7
11	--	--	--	--	--
12	21.1	16.5	--	3.7	24.8
13	21.1	--	--	3.5	83.0 (?)
14	21.6	--	--	2.9	63.7
15	22.2	--	--	4.5	54.7
Mouth of Purvis Creek (16)	22.4	25.0	--	7.2	33.3
Turtle River (17)	21.9	30.0	--	5.9	46.2
Southeastern corner (18)	--	--	--	--	--
		Northern Part of Site			
Mid-stretch Purvis Creek (29)	22.4	29.3	--	6.4	45.5
Southeastern corner (30)	--	--	--	--	--
South-central location (31)	--	29.6	--	--	39.0
Mouth of southern creek (32)	23	29.5	--	7.6	43.7
Near old oil-processing site (33)	--	--	--	--	--
Near county landfill (34)	--	--	--	--	--
Mouth of northern creek (35)	22.6	13.0	--	7.1	85.4 (?)
Upper Purvis Creek (36)	22.1	29.3	--	5.8	42.4
		Western Part of Site			
Mouth of southern creek (45)	22.1	29.9	--	5.8	43.2
		Reference Locations			
Troup Creek	19.1	16.8	7.5	6.7	27.4
Crescent River	18.5	34.3	7.5	5.5	52.0

[a]Creek surface water samples were collected during the period of October 13 - 19, 2000, typically during the early stages of ebb tide. The meter employed to take these measurements occasionally generated seemingly unreliable data, indicated in this table by "?."

Table 3.__Major chemicals of potential concern (COPC) in creek surface water of estuary at LCP Site[a]

Sampling station	Mercury (ng/L or ppt)[b] Total	Mercury Methyl (% of total)	Aroclor 1268[c] (ug/L or ppb)	Lead total / diss.[d] (ug/L or ppb)	Individual PAHs[e] (ug/L or ppb)
Southern Part of Site					
Main Canal (upstream to downstream)					
1	24	<0.025 (<0.10)	1.0U	5.0U / 5.0U	0 – 0.20U
2	14	0.20 (1.4)	1.0U	5.0U	0 – 0.20U
3	18	0.16 (0.89)	1.0U	5.0U	0 – 0.20U
4	14	0.22 (1.6)	1.0U	5.0U	0 – 0.20U
5 (Sample 1)	59	– (–)	1.0U	5.0U	0 – 0.20U
Eastern Creek (upstream to downstream)					
6	18	0.30 (1.7)	1.0U	5.0U	0 – 0.20U
7	20	0.29 (1.4)	1.0U	5.0U / 5.0U	0 – 0.20U
8	19	0.32 (1.7)	1.0U	5.0U	2 – 0.12J (F)
9	190	0.94 (0.49)	0.19J	5.0U	0 – 0.20U
Western Creek Complex (upstream to downstream)					
10	13	0.26 (2.0)	0.19J	5.0U	0 – 0.20U
11	25	0.49 (2.0)	1.0U	5.0U	0 – 0.20U
12	30	0.81 (2.7)	1.0U	5.0U	0 – 0.20U
13	18	0.25 (1.4)	1.0U	1.8B / 5.0U	0 – 0.20U
14	8.0	0.15 (1.9)	1.0U	5.0U	1 – 0.059J (F)
15	12	0.22 (1.8)	1.0U	5.0U	0 – 0.20U
Mouth of Purvis Creek (16)	16	0.20 (1.2)	1.0U	1.8B / 1.9B	0 – 0.20U
Turtle River (17)	16	0.28 (1.8)	1.0U	5.0U	0 – 0.20U
Southeastern corner (18)	420	12 (2.9)	1.0U	1.9B / 5.0U	0 – 0.20U
Seep location (AB)	7,800	23 (0.29)	0.52	1,400 / 28	1 – 2.5 (P)
Northern Part of Site					
Mid-stretch Purvis Creek (29)	24	0.38 (1.6)	1.0U	5.0U	0 – 0.20U
Southeastern corner (30)	77	16 (21)	1.0U	2.6B	5 – 6.8 (1M)
South-central location (31)	10	0.19 (1.9)	1.0U	5.0U	0 – 0.20U
Mouth of southern creek (32)	28	0.50 (1.8)	1.0U	5.0U / 5.0U	0 – 0.20U
Near old oil-processing site (33)	36	1.2 (3.3)	1.0U	7.0 / 2.3B	0 – 0.20U
Near county landfill (34)	61	8.4 (14)	1.0U	2.0B	0 – 0.20U
Mouth of northern creek (35)	37	0.50 (1.4)	1.0U	5.0U / 5.0U	0 – 0.20U
Upper Purvis Creek (36)	99	10 (1.0)	1.0U	5.0U / 5.0U	0 – 0.20U
Western Part of Site					
Mouth of southern creek (45)	11	0.17 (1.5)	1.0U	5.0U / 5.0U	0 – 0.20U
Reference Locations					
Troup Creek	3.3	0.038 (1.2)	1.0U	5.0U / 5.0U	0 – 0.20U
Crescent River	1.7	<0.025 (<1.5)	0.33J	5.0U / 5.0U	0 – 0.20U

[a]Creek surface water samples were collected during the period of October 13 - 19, 2000, typically during the early stages of ebb tide. General coding in table is as follows: U (undetected), J (present at > minimum detection limit but < reporting limit), and B (present in blank as well as sample).

[b]All mercury data reported in this table were generated by Frontier GeoSciences. (Data reported by STL Savannah Laboratories are not reported in the table.) The USEPA Region 4 chronic ecological screening value (ESV) for mercury (total mercury) is 25 ng/L.

[c]There is no USEPA Region 4 chronic ESV for Aroclor 1268. However, the Region 4 ESV for Aroclor 1254, which is generally considered to be a more toxic Aroclor, is 0.03 ug/L.

[d]The USEPA Region 4 chronic ESV for lead (total lead) is 8.5 ug/L.

[e]The coding in this "PAH" column reflects the number of individual PAHs detected at a sampling station (usually none or 0 out of 18 PAHs evaluated), then a double dash (–), followed by either the detection limit employed for all PAHs or the PAH found at the highest concentration. These PAHs are abbreviated as F (fluoranthene), P (pyrene), and 1M (1 - methylnaphthalene). None of these PAHs is associated with a USEPA Region 4 chronic ESV.

Table 4.__Physical/chemical characteristics and major chemicals of potential concern (COPC) in creek surface sediment of estuary at LCP Site (all measurements in dry weight)[a]

Sampling station	Silt and clay (%)	Total organic content (%)	Mercury (mg/kg or ppm))[b] Total	Mercury Methyl (% of total)	Aroclor 1268[c] (mg/kg or ppm)	Lead[d] (mg/kg or ppm)	Total PAHs[e] (mg/kg or ppm)
Southern Part of Site							
Main Canal (upstream to downstream)							
1	20	1.4	2.8	0.0066 (0.24)	1.7	18	0.039 / 1.090
2	38	2.7	0.78	0.0032 (0.41)	1.3	14	0.300 / 2.510
3	64	1.8	4.4	0.0011 (0.025)	20	22	0.175 / 0.777
4	88	4.7	2.7	0.0035 (0.13)	2.4	27	0.266 / 0.321
5	90	6.5	12	0.0023 (0.019)	3.7	36	0.120 / 0.870
Eastern Creek (upstream to downstream)							
6 (Location 5)	98	6.7	110	0.0018 (0.0016)	0.10U	45	0.837 / 0.917
7	96	7.5	30	0.0011 (0.0037)	23	38	0.086 / 0.779
8	93	5.9	8.3	0.00013 (0.0016)	2.2	62	5.350 / 7.825
9	97	2.6	1.1	0.0036 (0.0033)	0.23	43	0 / 1.710
Western Creek Complex (upstream to downstream)							
10	98	5.4	9.7	0.00053 (0.0055)	0.59	29	0.017 / 0.193
11 (Location 5)	98	7.5	2.0	0.00017 (0.0085)	2.0	27	0.075 / 0.215
12	97	5.5	5.3	0.0024 (0.045)	0.48	26	0.013 / 0.197
13	98	5.1	7.0	0.00059 (0.0084)	0.75	27	0.018 / 0.744
14	98	5.0	5.4	0.00050 (0.0093)	0.30	27	0.007 / 0.194
15	97	4.5	3.4	0.00072 (0.021)	0.099J	23	0.214 / 0.382
Mouth of Purvis Creek (16)	17	1.0	0.28	0.00083 (0.30)	0.60	3.7N	0.056 / 0.366
Turtle River (17)	44	3.2	0.15	0.00065 (0.43)	0.069	21N	0.091 / 0.168
Southeastern corner (18)	96	6.6	60	0.050 (0.083)	1.3	28	0.024 / 1.113

Table 4.__Continued

Sampling station	Silt and clay (%)	Total organic content (%)	Mercury (mg/kg or ppm))[b] Total	Mercury Methyl (% of total)	Aroclor 1268[c] (mg/kg or ppm)	Lead[d] (mg/kg or ppm)	Total PAHs[e] (mg/kg or ppm)
Northern Part of Site							
Mid-stretch Purvis Creek (29)	81	6.8	1.9	0.00066 (0.035)	1.1	26	0.220 / 0.328
Southeastern corner (30)	48	9.1	4.6	0.0083 (0.18)	1.5	1,100N	8.380 / 17.480
South-central location (31):							
Location 5	97	5.0	0.048	0.00012 (0.25)	0.018J	14	0 / 0.180
Mouth of southern creek (32)	74	5.5	1.3	0.011 (0.85)	0.63	20	0.057 / 0.693
Near old oil-processing site (33)	6.6	0.90	0.079	0.00034 (0.43)	0.015J	17	0.011 / 0.316
Near county landfill (34)	91	3.8	1.6	0.0035 (0.22)	0.059J	63	0.084 / 0.240
Mouth of northern creek (35)	98	5.0	1.7	0.0032 (0.19)	0.85	27	0 / 1.820
Upper Purvis Creek (36)	21	1.2	0.93	0.00053 (0.057)	0.59	13	0 / 0.835
Western Part of Site							
Mouth of southern creek (45)	97	4.6	0.15	0.0011 (0.73)	0.061J	15N	0.027 / 0.160
Marsh Grid							
B7	97	5.8	6.6	0.0013 (0.020)	15	28	0.485 / 1.612
D9	97	7.3	2.3	0.013 (0.57)	1.4	28	0 / 0.884
H7	94	6.4	4.2	0.00088 (0.021)	17	50	0.061 / 0.754
K7	85	4.2	3.1	0.00057 (0.0018)	0.33	47	11.330 / 12.161
N2	77	8.1	12	0.028 (0.23)	0.63	29	0.452 / 1.264
Reference Locations							
Troup Creek	44	2.1	0.24	0.00022 (0.092)	0.089U	12	0 / 1.255
Crescent River	8.2	0.33	0.0076	<0.000010 (<0.13)	0.044U	2.0	0 / 0.300

[a]Creek surface sediment (0 - 15 cm in depth) was collected during the period of October 13 - 19, 2000. General coding in table is as follows: U (undetected), J (present at > minimum detection limit but < reporting limit), and N (spike recovery not within control limits).

[b]All mercury data reported in this table were generated by Frontier GeoSciences. (Data reported by STL Savannah Laboratories are not reported in the table.) The USEPA Region 4 ecological effects value (EEV) for mercury (total mercury) is 0.13 mg/kg.

[c]There is no USEPA Region 4 EEV for Aroclor 1268. However, the Region 4 EEV for total PCBs is 0.0216 mg/kg.

[d]The USEPA Region 4 EEV for lead is 30.2 mg/kg.

[e]Two total PAH values are presented for each sampling station. The first value (to the left of "/") is the total for just detected PAHs. The second value (to the right of the "/") is the total for detected PAHs plus 1/2 of the detection limits for non-detected PAHs. The USEPA Region 4 EEV for total PAHs is 1.684 mg/kg.

Table 5.__Physical/chemical characteristics and major chemicals of potential concern (COPC) in marsh surface sediment of estuary at LCP Site (all measurements in dry weight)[a]

Sampling station	Silt and clay (%)	Total organic content (%)	Mercury (mg/kg or ppm)[b] Total	Mercury (mg/kg or ppm)[b] Methyl (% of total)	Aroclor 1268[c] (mg/kg or ppm)	Lead[d] (mg/kg or ppm)	Total PAHs[e] (mg/kg or ppm)
Southern Part of Site							
Main Canal (upstream to downstream)							
25	26	2.0	0.76	0.0021 (0.0028)	0.66	16	0.521 / 0.557
26	93	6.9	1.7	0.011 (0.65)	1.9	22	0.304 / 0.384
Streamlet to Main Canal (19)	10	1.1	0.21	0.00068 (0.32)	0.14	2.4	0 / 0.301
Eastern Creek (upstream to downstream)							
20	60	3.7	29	0.0032 (0.011)	2.2	25	0.013 / 0.181
21	98	5.7	63	0.013 (0.021)	2.2	46	0.040 / 0.216
22	96	5.1	17	0.012 (0.071)	2.0	30	0.007 / 0.194
23	96	4.8	16	0.0059 (0.037)	4.9	28	0.016 / 0.816
24	97	4.9	2.9	0.012 (0.41)	3.3	34	0.174 / 1.074
Western Creek Complex (27)	99	4.7	3.3	0.0064 (0.19)	0.47	26	0 / 0.748
Mouth of Purvis Creek (28)	92	4.9	0.53	0.0024 (0.45)	0.31	22N	0.010 / 0.162
Seep location (AB)	6.6	0.68	0.56	0.00056 (0.10)	0.15	120	0.64 / 0.89
Northern Part of Site							
Southeastern corner (37)	95	8.2	2.9	0.020 (0.69)	0.32	56N	0.128 / 0.895
South-central location (38)	98	6.1	1.9	0.0094 (0.49)	0.62	25	0.051 / 0.207
Mouth of southern creek (39)	98	5.9	0.61	0.0040 (0.66)	0.27	19N	0.017 / 0.652
Near old oil-processing site (40)	7.2	0.66	0.12	0.00044 (0.37)	0.043J	14	0.106 / 0.385
Near county landfill (41)	80	6.1	3.2	0.044 (1.4)	0.52	91	0.796 / 0 859
Northern Creek (upstream to downstream)							
42	98	5.4	0.68	0.0055 (0.81)	0.24	23N	0.075 / 0.196
43	98	4.9	0.89	0.0057 (0.64)	0.45	25	0 / 1.400
Upper Purvis Creek (44)	98	5.7	1.5	0.013 (0.87)	0.57	27	0.224 / 0.350
Western Part of Site							
Mouth of central creek (46)	98	4.6	0.69	0.0026 (0.38)	0.17	23N	0.039 / 0.613

Table 5.__Continued

Sampling station	Silt and clay (%)	Total organic content (%)	Mercury (mg/kg or ppm)[b] Total	Mercury (mg/kg or ppm)[b] Methyl (% of total)	Aroclor 1268[c] (mg/kg or ppm)	Lead[d] (mg/kg or ppm)	Total PAHs[e] (mg/kg or ppm)
Marsh Grid							
B7	98	5.3	1.3	0.011 (0.84)	1.0	26	0.218 / 0.336
D9	98	6.6	2.5	0.0085 (0.34)	2.4	24	0 / 0.225
H7	98	5.5	12	0.014 (0.12)	0.94	29	0.011 / 0.215
K7	89	5.0	4.5	0.013 (0.29)	3.5	29	0 / 0.990
N2	94	6.8	50	0.032 (0.064)	--	35	--
Reference Locations							
Troup Creek	99	4.8	0.28	0.00040 (0.14)	0.063U	24	0.005 / 0.431
Crescent River	34	0.26	0.0032	<0.000010 (<0.31)	0.046U	5.9	0 / 0.314

[a]Creek surface sediment (0 - 15 cm in depth) was collected during the period of October 13 - 19, 2000. General coding in table is as follows: U (undetected), J (present at > minimum detection limit but < reporting limit), and N (spike recovery not within control limits).

[b]All mercury data reported in this table were generated by Frontier GeoSciences. (Data reported by STL Savannah Laboratories are not reported in the table.) The USEPA Region 4 ecological effects value (EEV) for mercury (total mercury) is 0.13 mg/kg.

[c]There is no USEPA Region 4 EEV for Aroclor 1268. However, the Region 4 EEV for total PCBs is 0.0216 mg/kg.

[d]The USEPA Region 4 EEV for lead is 30.2 mg/kg.

[e]Two total PAH values are presented for each sampling station. The first value (to the left of "/") is the total for just detected PAHs. The second value (to the right of the "/") is the total for detected PAHs plus 1/2 of the detection limits for non-detected PAHs. The USEPA Region 4 EEV for total PAHs is 1.684 mg/kg.

TOTAL PAH CONCENTRATIONS (mg/kg, dry weight)
IN CREEK SURFACE SEDIMENT
METHOD 1

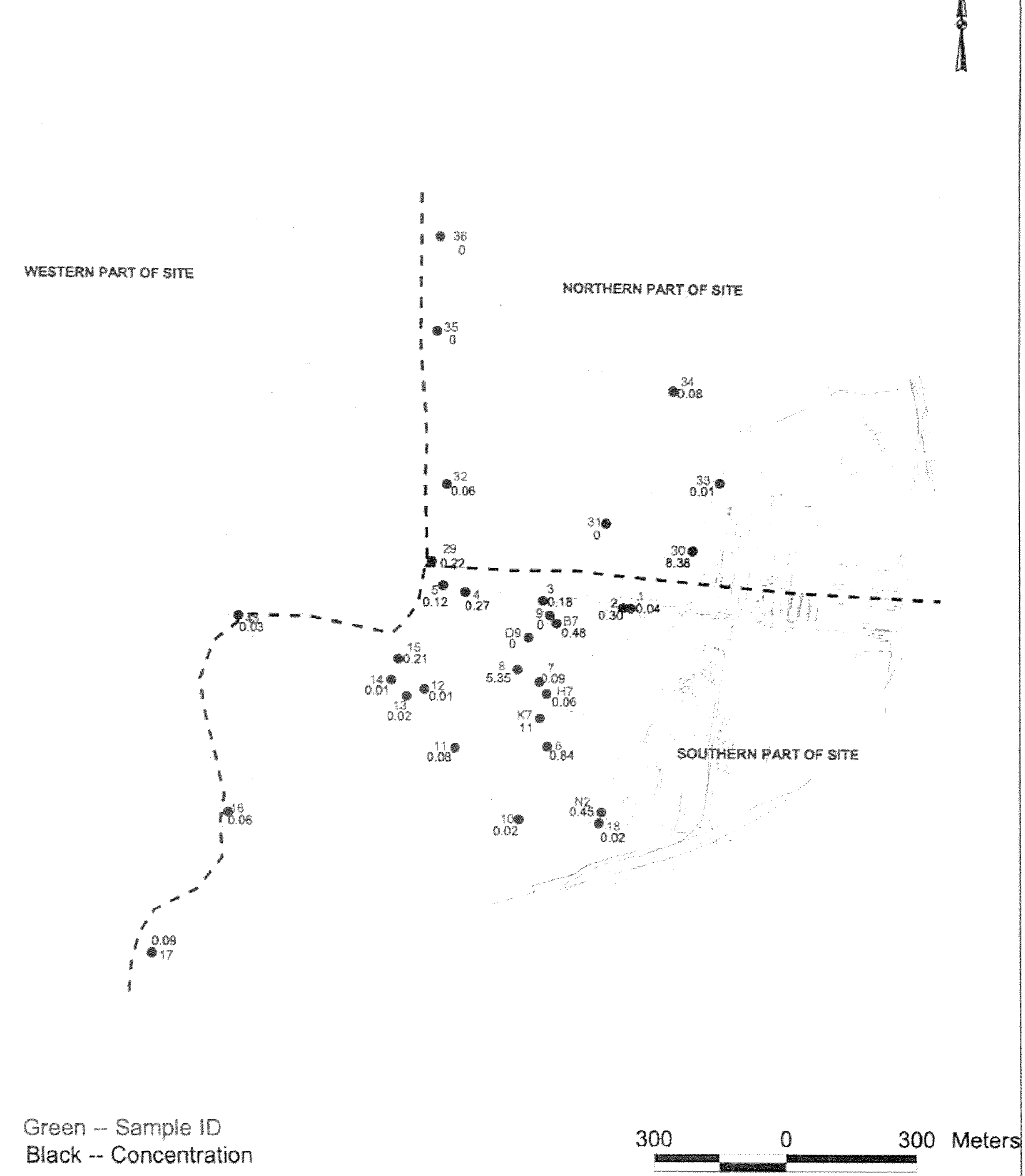


PLATE NO.	7
DOCUMENT NO.	
FILE NO.	SED CHEM_2000.APR

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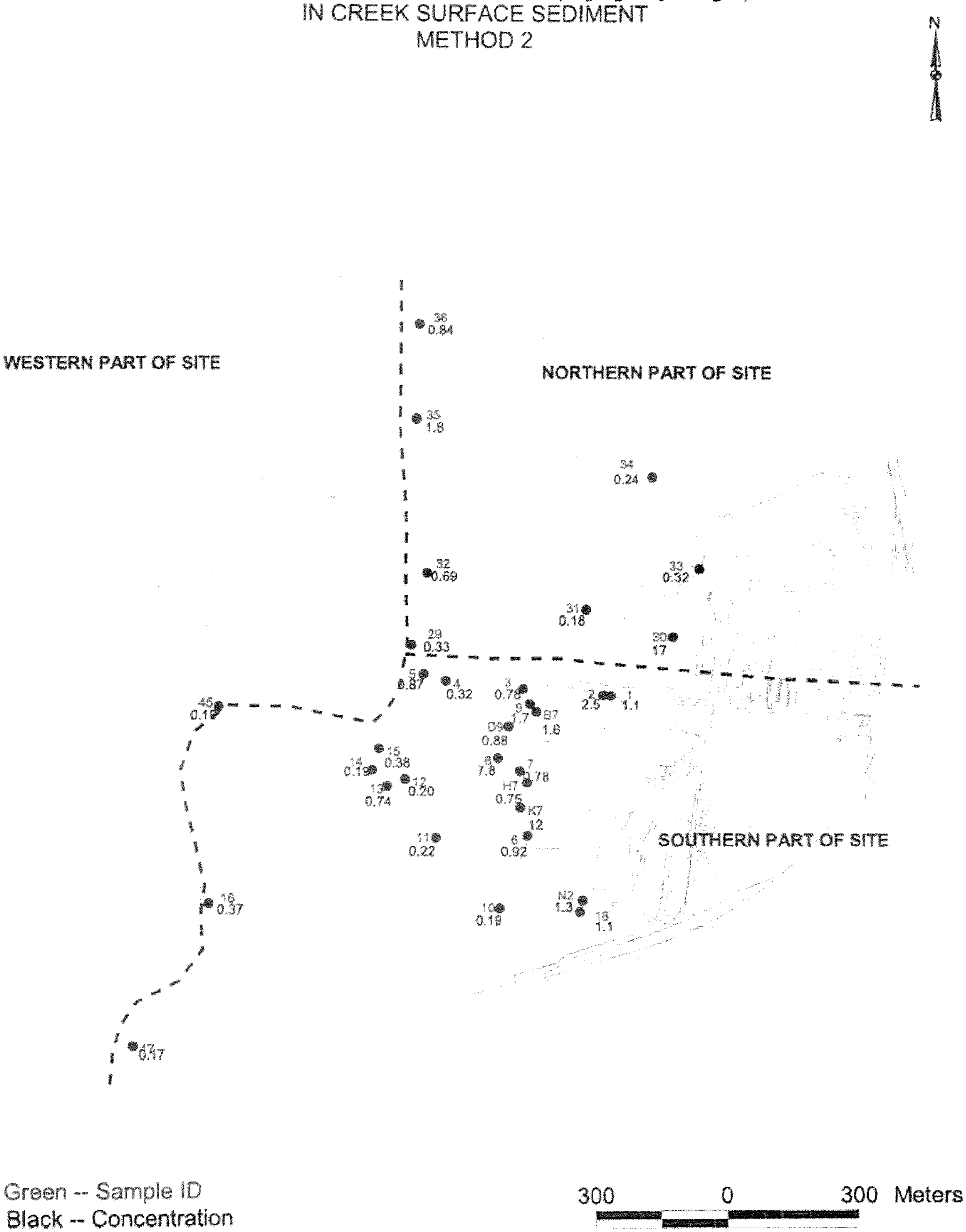
TOTAL PAH CONCENTRATIONS (mg/kg, dry weight)
IN CREEK SURFACE SEDIMENT
METHOD 2



Green -- Sample ID
Black -- Concentration

PLATE NO.	8
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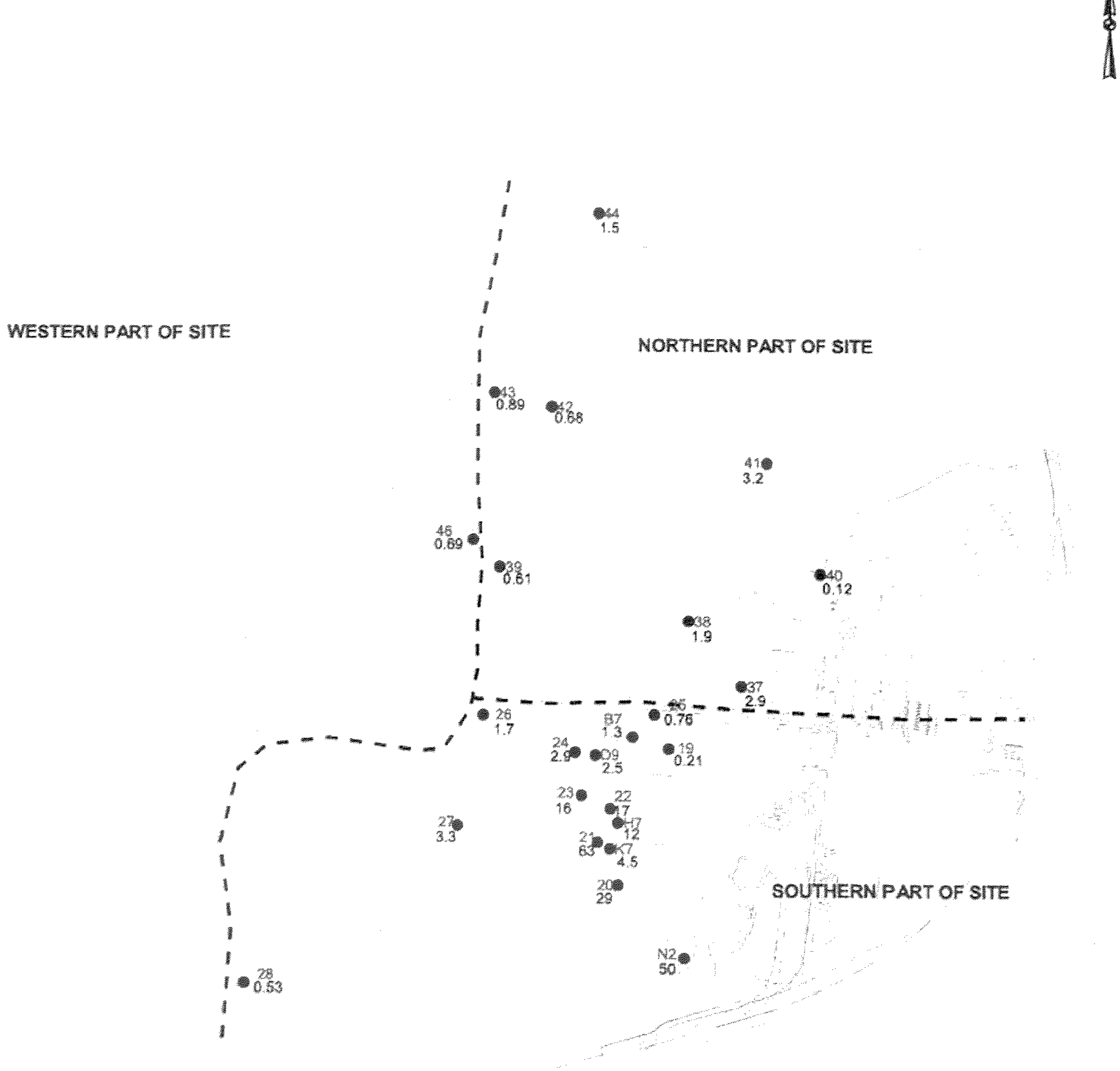
TOTAL MERCURY CONCENTRATIONS (mg/kg, dry weight)
IN MARSH SURFACE SEDIMENT



Green -- Sample ID
Black -- Concentration

300 0 300 Meters

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PLATE NO.	9
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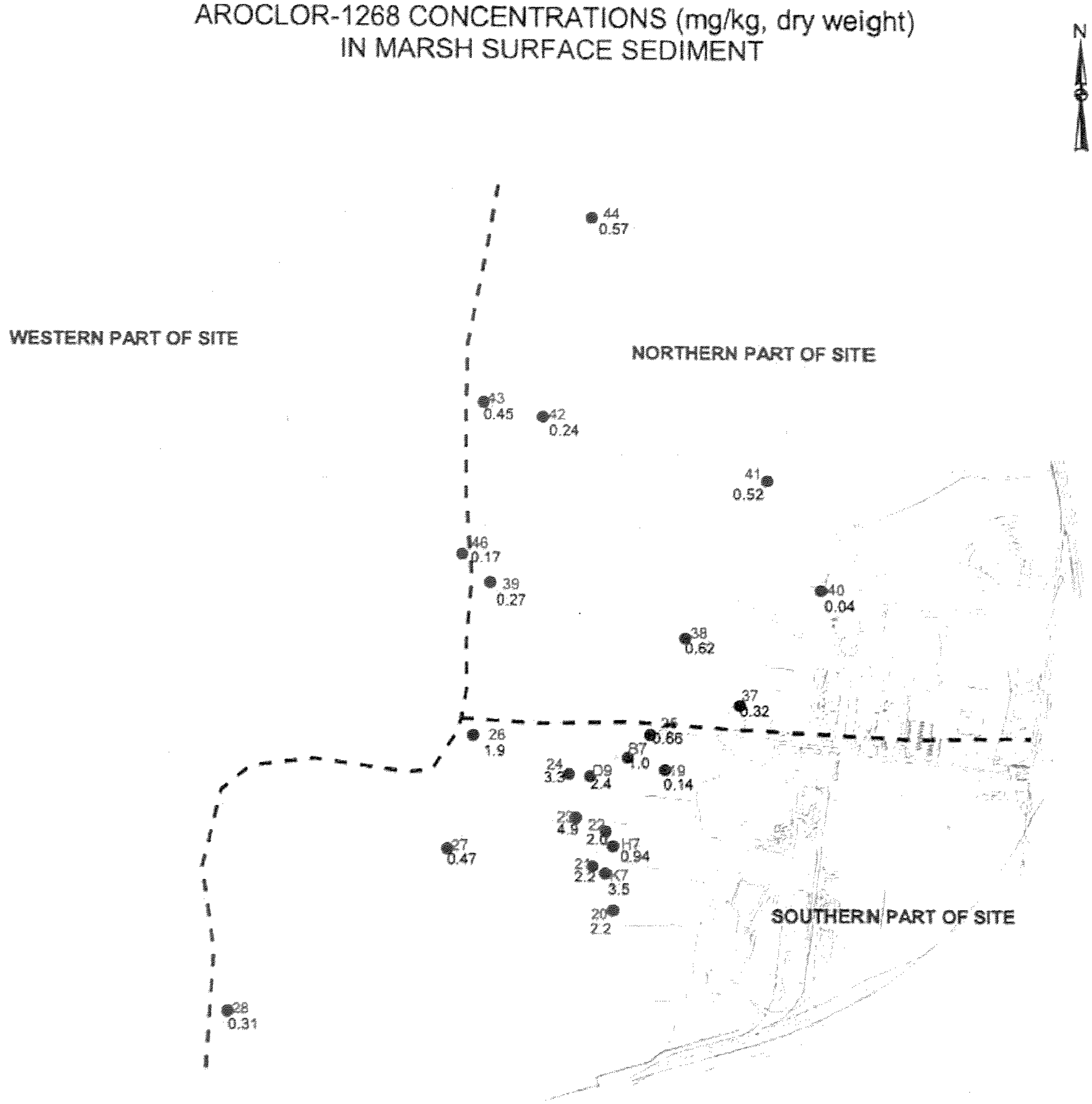
AROCLOR-1268 CONCENTRATIONS (mg/kg, dry weight) IN MARSH SURFACE SEDIMENT



Green -- Sample ID
Black -- Concentration

300 0 300 Meters

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FILE NO.	SED CHEM_2000.APR

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LEAD CONCENTRATIONS (mg/kg, dry weight) IN MARSH SURFACE SEDIMENT

N

Green -- Sample ID
Black -- Concentration

300 0 300 Meters

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	DOCUMENT NO.
	FILE NO. SED CHEM_2000.APR

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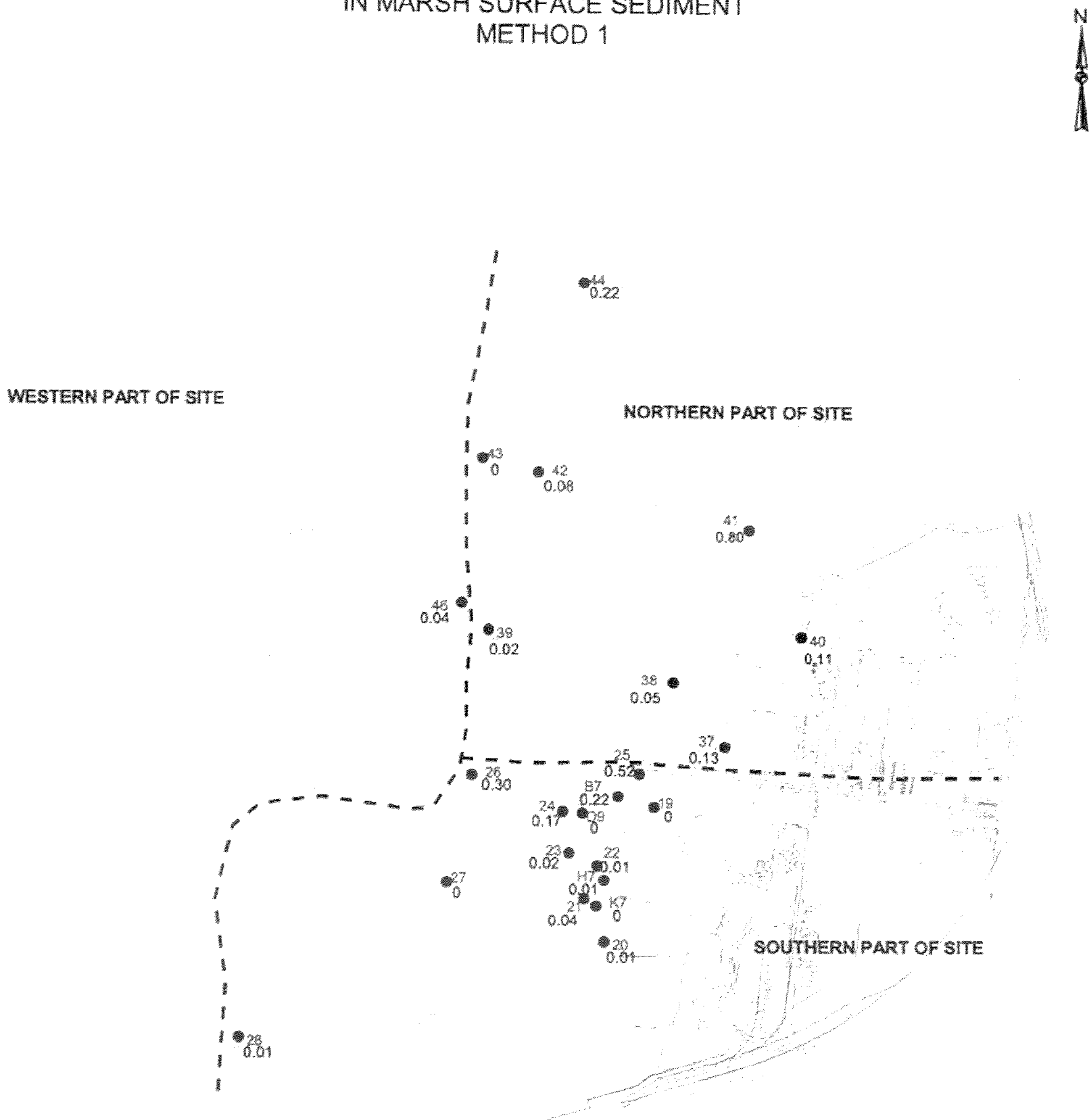
TOTAL PAH CONCENTRATIONS (mg/kg, dry weight) IN MARSH SURFACE SEDIMENT METHOD 1



Green -- Sample ID
Black -- Concentration

300 0 300 Meters

PLATE NO.	12
DOCUMENT NO.	
FILE NO.	SED CHEM_2000.APR

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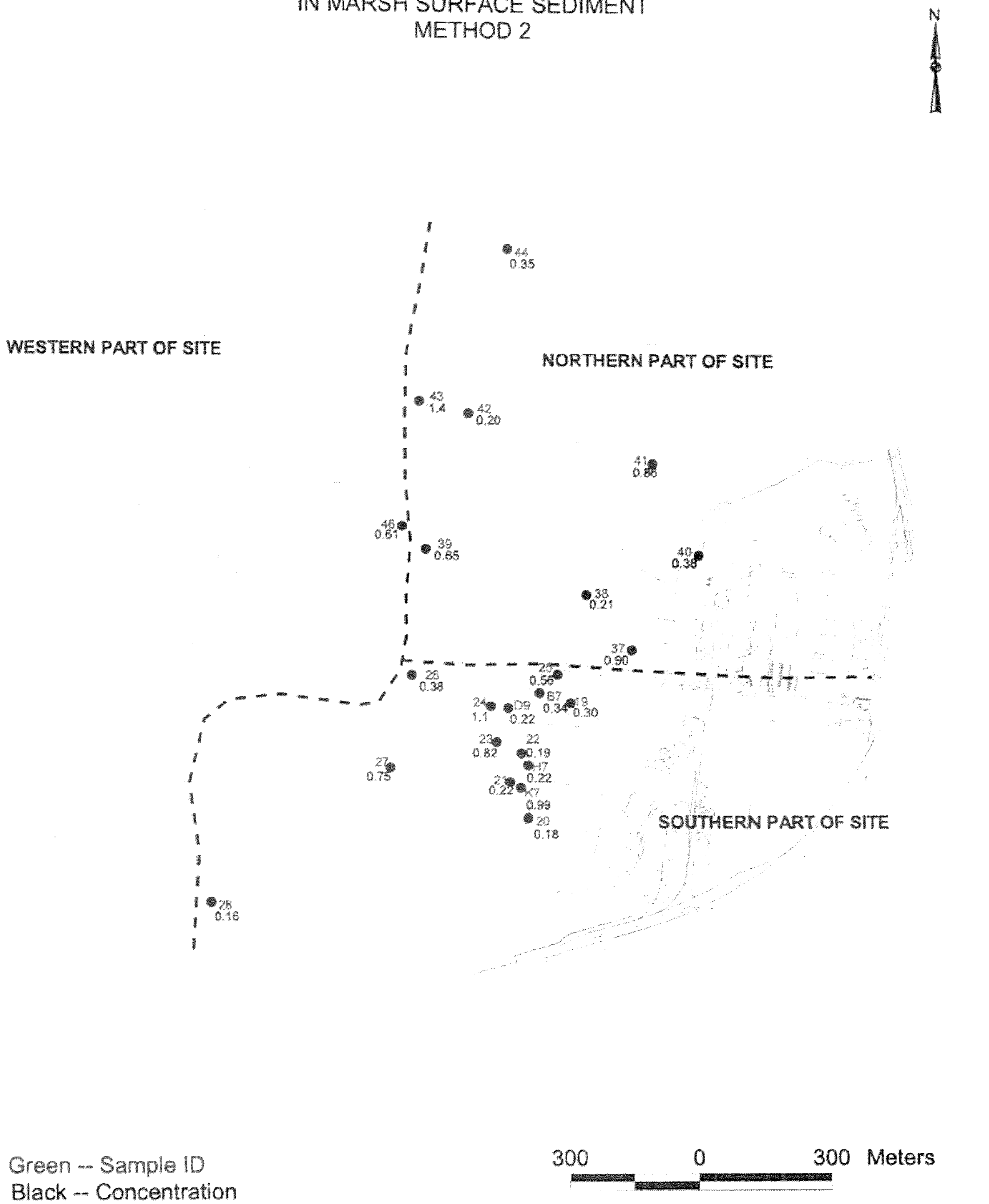
TOTAL PAH CONCENTRATIONS (mg/kg, dry weight)
IN MARSH SURFACE SEDIMENT
METHOD 2



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	DOCUMENT NO.
	FILE NO. SED CHEM_2000.APR

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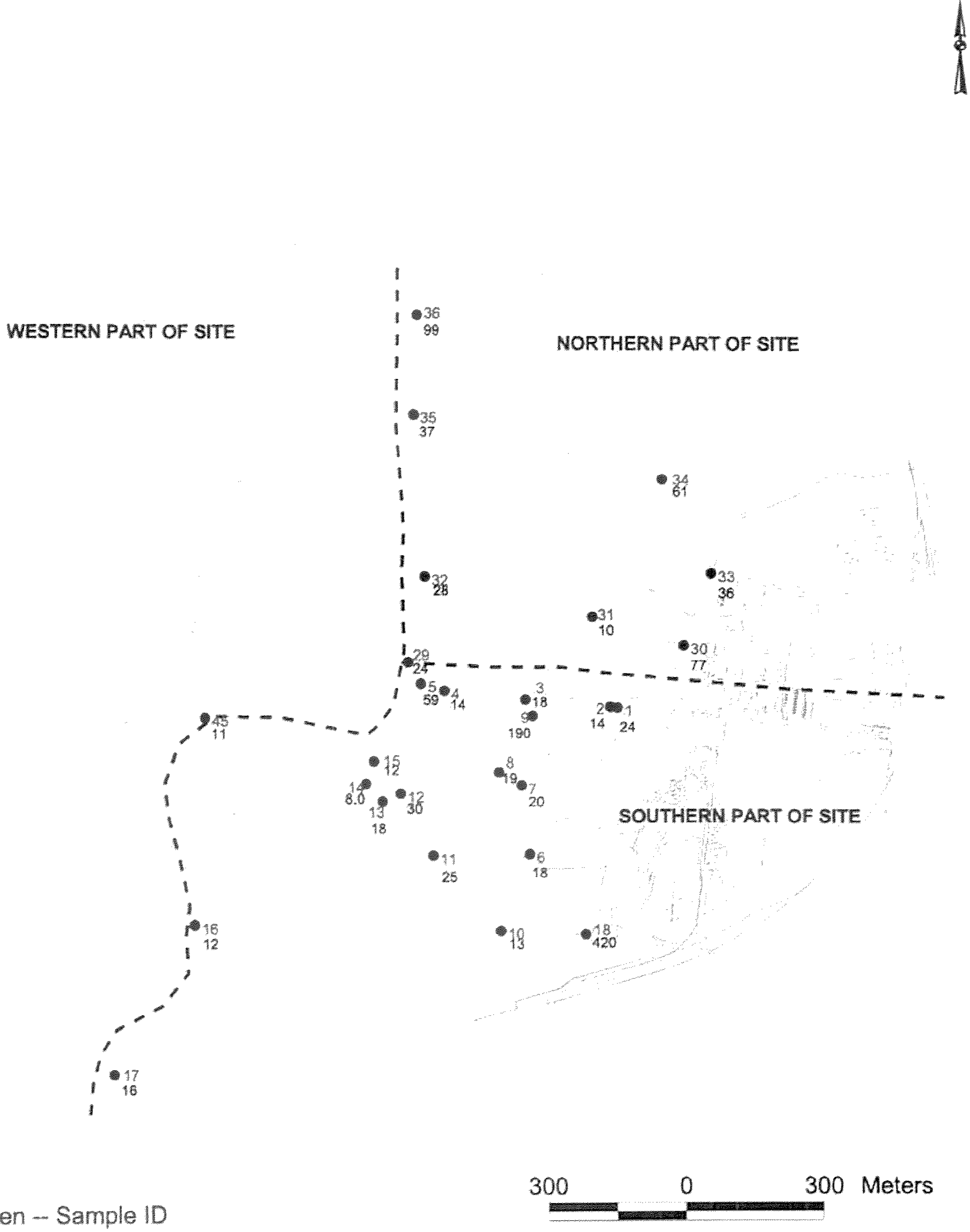
TOTAL MERCURY CONCENTRATIONS (ng/L)
IN CREEK SURFACE WATER



Green -- Sample ID
Black -- Concentration

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	DOCUMENT NO.
	FILE NO. WATER CHEM_2000.APR

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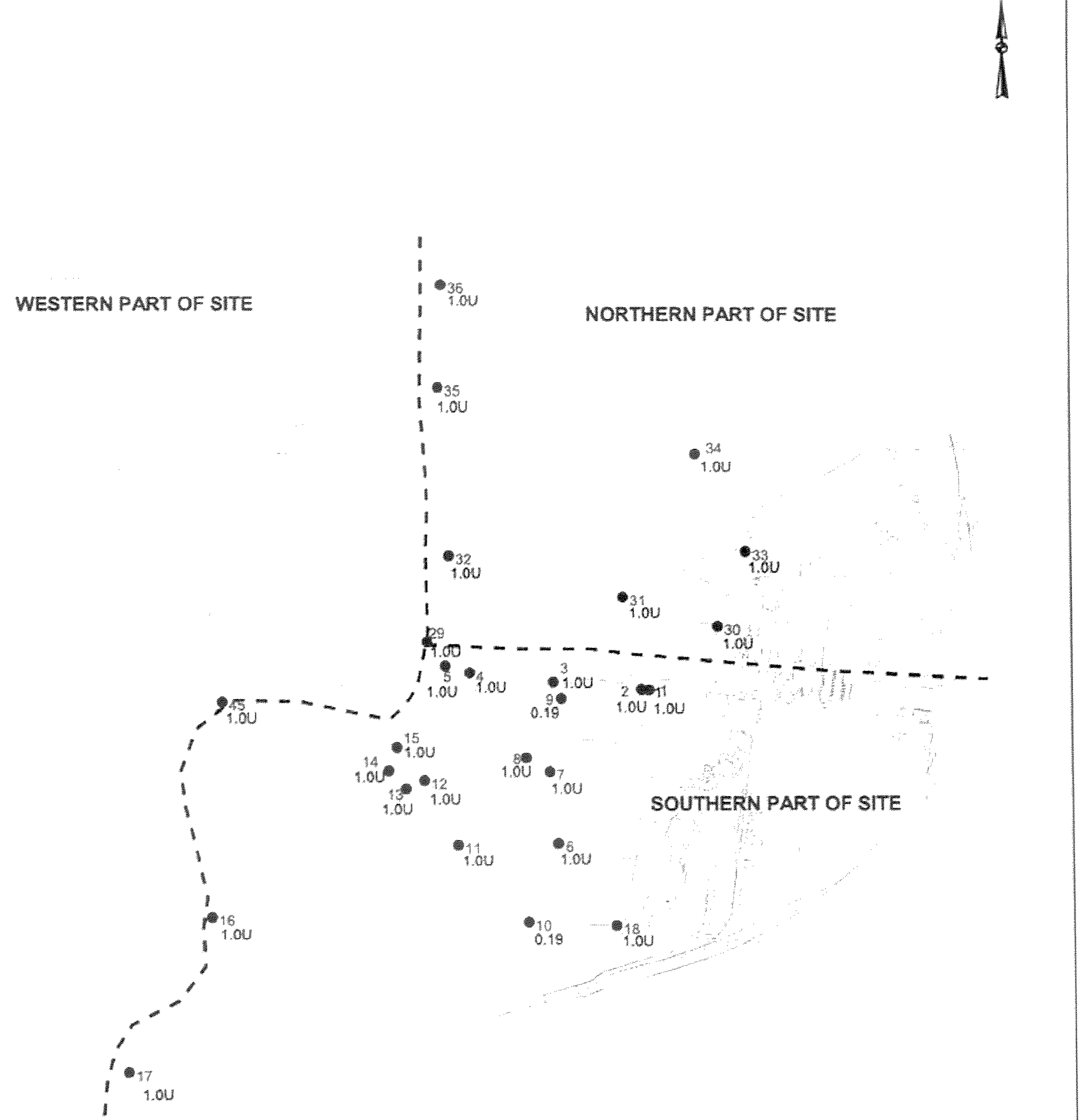
AROCLOR-1268 CONCENTRATIONS (ug/L)
IN CREEK SURFACE WATER



Green -- Sample ID
Black -- Concentration

300 0 300 Meters

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PLATE NO.	2
DOCUMENT NO.	
FILE NO.	WATER CHEM_2000.APR

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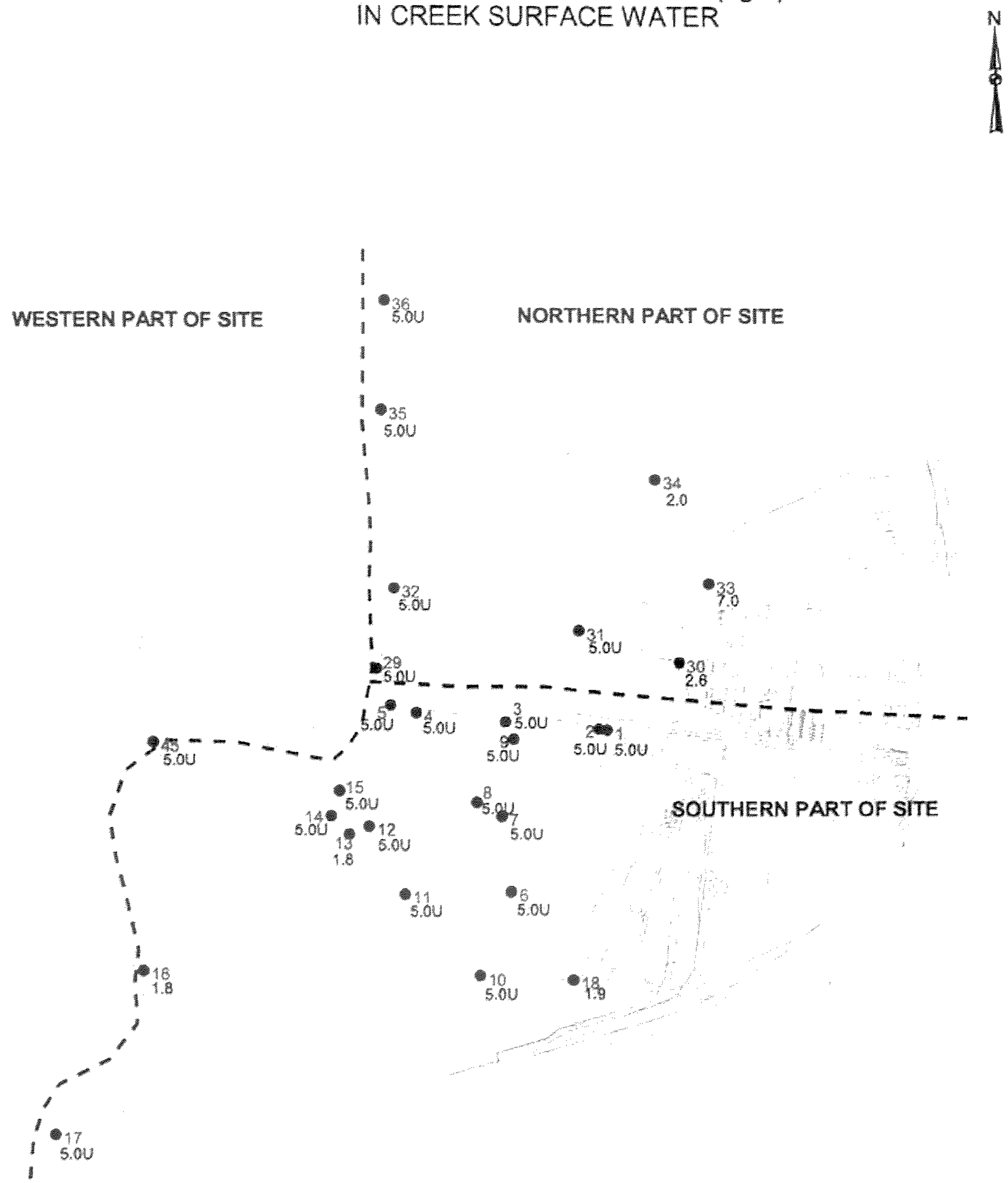
TOTAL LEAD CONCENTRATIONS (ug/L)
IN CREEK SURFACE WATER



Green -- Sample ID
Black -- Concentration

300 0 300 Meters

PLATE NO.	3
DOCUMENT NO.	
FILE NO.	WATER CHEM_2000.APR

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TOTAL MERCURY CONCENTRATIONS (mg/kg, dry weight) IN CREEK SURFACE SEDIMENT

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	DOCUMENT NO.
	FILE NO. SED CHEM_2000.APR

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AROCLOR-1268 CONCENTRATIONS (mg/kg, dry weight)
IN CREEK SURFACE SEDIMENT

PLATE NO.	5
DOCUMENT NO.	
FILE NO.	SED CHEM_2000.APR

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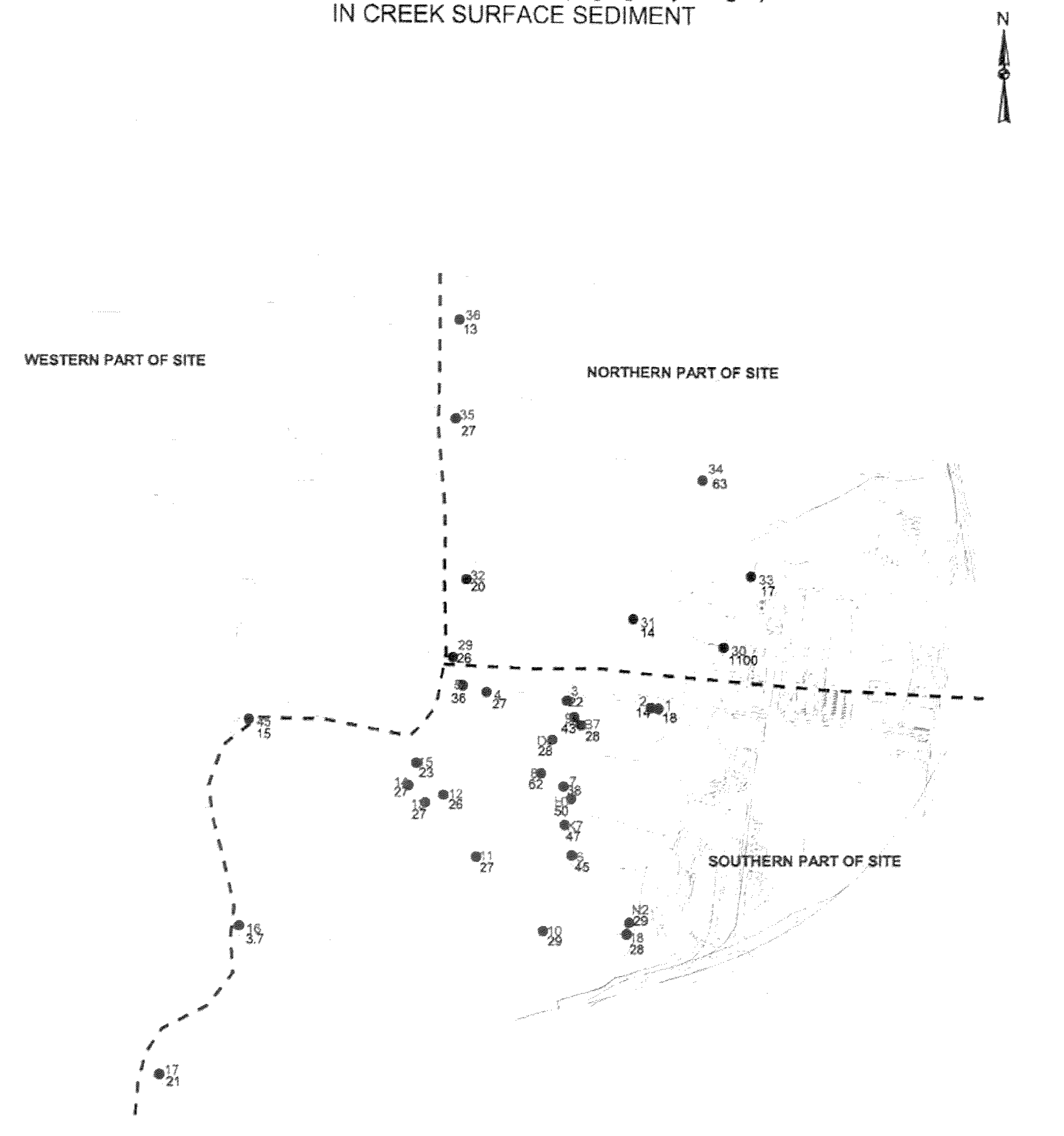
LEAD CONCENTRATIONS (mg/kg, dry weight)
IN CREEK SURFACE SEDIMENT



Green -- Sample ID
Black -- Concentration

300 0 300 Meters

PLATE NO.	6
DOCUMENT NO.	
FILE NO.	SED CHEM_2000.APR

GeoSyntec Consultants
ATLANTA, GEORGIA

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